CHEMICAL ENGINEERING

with CHEMICAL & METALLURGICAL ENGINEERING

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THE TEXAS TRAGEDY

A TRULY tragic chapter in the history of the American chemical industry was written last month in Texas City. All the sympathies of a war-torn world have gone to those who suffered such tremendous losses in life and property. That this catastrophe should have been caused by the careless handling of a chemical product is deeply regretted—the more so because that ingredient of wartime explosives had been destined to play a more benevolent role in the relief of famine and human suffering abroad. But it is to the lasting credit of the chemical profession that men and women like those of Monsanto are resolved to carry on, to rebuild with the same zeal and energy that has already made Texas a great frontier of progress in the process industries.

"THE PRODUCT THAT COULDN'T EXPLODE"

OUR sympathies, in much lesser measure, also go out to those oracles from Atlantic City and elsewhere who overnight became experts on the explosibility of ammonium nitrate. Over the radio and in the syndicated columns came many weird announcements. Sadly, we were reminded of our own rather immature outgivings of more than 25 years ago when, following the great Oppau explosion in September 1921 we penned an editorial entitled "Facts and Fancies About Ammonium Nitrate." We think we learned a lesson. Certainly the resulting series of conferences with federal and state officials, insurance inspectors and explosives manufacturers taught us that solid facts are better than fleeting fancies as a foundation for editorial comment.

But that experience had a most beneficial result in persuading the great explosives expert, Dr. Charles E. Munroe, to write the classic article on "The Explosibility of Ammonium Nitrate" which was published in our March 22, 1922, issue. This reviewed the records of all known accidents involving this material and presented and interpreted the results of exhaustive tests made by the late Fred C. Zeisberg for a special committee of the National Research Council.

During the next few years further studies of the behavior of ammonium nitrate were made by committees here and in Germany. Following another disastrous explosion at Nixon, N. J., we published in our April 21, 1924, issue a translation of the official German report by Dr. Rudolf Aufschlaeger. Qualified experts from government and industry, in commenting on this article, agreed that while ammonium nitrate is extremely insensitive, it can be detonated with certainty under some conditions. *Per se* it is not an "explosive." Yet, as Dr. Munroe reported then, "The fact that ammonium nitrate possesses such (disastrous) potentialities should be impressed by continued reiteration upon all dealing with this substance."

Over the years, we have tried to do our share of that reiteration. If you have a 1944 volume handy, turn to the article on page 101 of the April issue, which is entitled "Ammonium Nitrate Hazards in Handling as a Fertilizer." Here Dr. R. O. E. Davis of the U. S. Department of Agriculture sounded some exceedingly pertinent warnings which, if followed to the letter, might well have prevented the fire and subsequent explosion of the Grandcamp's cargo as it lay along the dock at Texas City on the morning of April 16, 1947.

Elsewhere in this issue are Jack Hightower's first-hand report and photographs from the scene of this great disaster. No one regrets more than we that he should have had to undergo this "baptism of fire" during his first week in our new editorial offices in nearby Houston. Let us hope his future assignments are more pleasant and less strenuous!

Also in this issue is the concluding article in Colonel Crosby Field's series on accidental explosions. By curious coincidence, this describes the only serious explosion of ammonium nitrate that occurred in an American munitions plant during World War II. Significantly, the author calls it "The Product That Couldn't Explode." But whoever said that had failed to read the voluminous and valuable records of the past.

ANOTHER LESSON FROM TEXAS CITY

ANY disaster of the magnitude of the Texas City explosion and fire can teach many lessons. Public officials and industrial executives will be studying that case and learning from it for a long time to come. One of the lessons which we may learn seems likely to be overlooked. It is worth careful study.

We refer to the hazard of handling large quantities of ammonium nitrate at a point where the secondary effect of an explosion may be of such serious proportions. It is now evident, as it should have been evident before, that trans-shipment of this material from rail to water carrier should not be carried out at such locations as the Texas City waterfront. Nor should vessels loaded with commodities of this character be allowed to anchor or dock at similar points.

There are enough places where harbor facilities can be

used for this movement of ammonium nitrate so that a choice of an industrial area or an area near many residences should not be permitted. We hope that such a limitation as is evident in hindsight may be fixed for the future.

THE CASE FOR BIOCHEMICAL ENGINEERING

This is not a plea for another branch of engineering. There are too many already. But there is an important need in chemical industry today for engineers with somewhat broader scientific training than in chemistry, physics and mathematics. And this need will continue to grow as we come nearer to understanding and influencing the processes of our very existence. We are referring, of course, to the increasingly important role of the biological sciences.

In the past five years the pharmaceutical industries have contributed more to chemical progress, and in turn have been benefited more by chemical engineering progress, than ever before in their long history. The sulfas, blood plasma, penicillin and streptomycin, in rapid succession, have called for entirely new plants and processes. For almost the first time, the pharmaceutical manufacturers have been faced with the opportunity to use the well developed techniques and equipment that characterize efficient chemical engineering production. They have drawn heavily on the best of our technology and have often surprised themselves with the resultant savings in time, cost and quality. They want now to apply the same methods and equipment to other products, but they tell us they are handicapped by lack of engineering manpower with fundamental knowledge and experience in biology—particularly bacteriology and biochemistry.

The organic chemical industries have learned some costly lessons from the toxicologists. No manufacturer, sensitive to public responsibilities, would any longer think of introducing a solvent or plasticizer without thorough study of all potential hazards in its use or misuse by uninformed customers. As a result the chemical makers have set up their own biochemical laboratories or have turned for help to properly equipped universities and research institutions.

The whole field of industry which for lack of a better name we call "agricultural chemicals" is having a rebirth of energy and enthusiasm as advances are made so rapidly among insecticides and fungicides, weed killers, seed and soil disinfectants, plant hormones and rare element fertilizers. Much of this new business has grown out of the work of agricultural scientists—or rather through their closer cooperation with chemical manufacturers. That liaison has been effected more easily than in the fields of medicine and toxicology but again it is probably because chemical engineers have had more experience in studying and serving the farmers' needs.

Textiles, particularly new synthetic fibers of both organic and inorganic origin, have had to meet and overcome physiological as well as psychological obstacles. New dyes and finishes must win the approval of the biological laboratories as well as the dictators of fads and fashions. Markets for new paper and leather products, soap and cleaners, cosmetics and toiletries, are determined with an eye to health and human hazards. Tetraethyl lead would never have made its great contributions to automotive and air transportation had it not been for rigorous research into safe methods of manufacture and distribution.

So, it seems to us, that perhaps we have been all too slow in recognizing the need for better training of chemical engineers in the border sciences of biology. No one wants to add to the overburdened curricula in our undergraduate courses. No one wants to crowd out broad fundamentals with narrow specialties. But some of our older and better equipped institutions might make a real contribution to chemical engineering education if they could work out well-balanced five- or six-year courses that would give their graduates a better grasp of life processes. And they would be contributing a lot to the health and happiness as well as to the comfort and conveniences of modern living.

STOPPING FREIGHT LOSSES

Again this year the annual report of the chief inspector of Association of American Railroads gives great satisfaction to industry by showing the very small loss through fire and explosion caused by rail transportation of immense quantities of explosives and other potentially dangerous articles. A remarkably fine job has been done through the conscientious effort of shippers and carriers.

But we can all wish that the record might be still further improved, as nothing short of perfection is thoroughly satisfactory. Thus, we analyze critically the 949 accidents which caused a gross freight loss of $399,413 during 1946. We note that more than half of these in number were caused by either improper packaging, improper loading or defective containers. Of that substantial number of accidents, the process industries must share some responsibility.

Let us hope that we may further reduce the number and the losses by even more critical attention to detail. If we do that, we can also hope that derailment, collision, and rough handling, which are obviously carrier-caused difficulties, may be reduced. And they occasion a very much larger loss, though a much smaller number of accidents.

AS REQUESTED

Remember Henry Eckhardt's article last September entitled "Needed: Standard Cost Estimating Data for the Process Industries"? That started something. We were deluged with letters urging us to help in making process equipment costs available in useful form and at a central source. That interest was quickly confirmed when a questionnaire to two thousand readers showed a vote of 91 percent in favor of such a program. Other articles followed Eckhardt's at almost monthly intervals. Meanwhile, after consultation with many eminent engineers and equipment manufacturers, the editors decided to make "Process Equipment Costs" the subject of this month's special report. A lot of thought and hard work, by editors and contributors alike, has gone into its 32 pages. Yet we realize it is but the start of a continuing and broader program that can only be developed fully with your cooperation and support. May we count on you for your share in this group effort?

REPORT ON . . . .

Process Equipment Cost ESTIMATION

There has never been much published information in the past to aid chemical engineers in the estimation of process equipment and plant costs. Part of the difficulty has been that much process equipment is special rather than standard. Part has come from the fact that such data grow old quickly, and it has not seemed worth while to put a great deal of effort into their accumulation without some means for keeping them current. For several months past CHEMICAL ENGINEERING *has been exploring the possibilities for presenting data of sufficient accuracy for pre-construction cost estimating and, at the same time, of providing means for periodically adjusting the data to keep abreast of cost changes. The present Report is an introduction to that program. Not all of the problems have been solved, but a start has been made and much more information will become available in ensuing months.*

CHEMICAL ENGINEERING deals not only with the development, design and construction of plants for carrying out chemical processes, but it is also much concerned with the economics of processes. Not only questions of technical feasibility but also those of dollars-and-cents practicability must be answered by the efforts of the engineer. Having determined that the process will work, he must also know what its production cost will be, what the product can be expected to gross, and what net return on the investment can be anticipated. He must be not only a technologist, but also in a sense a business man.

The first ingredient in process cost is capital investment since the building of a plant must precede its operation. How is the engineer to determine what investment is required for any proposed process? Obviously not by "reading a book" or pulling figures out of the air. Once his flow sheet has been perfected (with or without a pilot plant), once his bill of materials has been developed down to the last valve and foot of pipe, his only recourse is the securing of firm bids on every item required, the careful investigation of all construction and installation costs, and the application of factors of experience in estimating the unpredictable expenses that are certain to arise. But the time of final design is not the only time when capital costs must be estimated. A plant's construction blue prints must grow through earlier stages, when neither large appropriations, complete flow sheets, nor detailed lists of requirements are available.

Cost Estimates Needed

In early feasibility studies, in comparing two or more possible processes, in deciding whether a complete job of engineering is justified, those are the times when data suitable for pre-construction cost estimating are needed. Then the problem is to estimate plant, raw material and other operating costs with perhaps plus or minus 15 or 20 percent accuracy, and to do so without the expenditure of a great deal of time and effort. An ideal set-up for such work would involve data compilations on costs and capacities of all sorts of process equipment, estimating factors for determining approximate investment costs for power and other services, and means for approximating all the necessary operating expenditures including materials, attendance, supervision and overhead items. This is the problem the editors of *Chemical Engineering* have set for themselves. Its first phase, equipment costs, will be treated here and in subsequent issues.

Last September an article by Henry Eckhardt drew attention to these needs and to the paucity of existing information. Reader response was immediate and gratifying. Mr. Eckhardt's suggestions brought numerous offers of assistance, and much worthwhile

advice. Several months of study have shown that a great deal of cost information can be secured and correlated. Many people who formerly felt that the project was not feasible now believe that the reverse is true. A dozen or more articles in addition to those in this issue are already in progress or actually in hand, and others are being actively sought.

In some particulars the effort has not been a complete success, partly because ways have not yet been worked out for covering all sorts of equipment, but even more because of the present unreliability of much cost information. Following the end of Government price control, equipment prices rose in a most irregular fashion, and the normal relations among various equipment classes have largely disappeared. Furthermore, escalator clauses have often meant that firm prices did not exist. Still, there is evidence now that prices are becoming stable, although at a high level. More and more manufacturers are again quoting firm prices and escalation may soon be a thing of the past. As this effort continues in later issues it is felt that present deficiencies may be eliminated and present data amplified and improved.

In concluding this introductory section the editors wish to pay tribute to Mr. Eckhardt's continued interest in, and assistance with, this project. Not satisfied merely to see it started, he has worked actively toward its achievement, both in its planning and in its execution. It is only fitting then that he should record below some of his philosophy regarding cost data and their place in the chemical engineer's kit of working tools.

Price and Cost—an Analysis

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PRICE AND COST are related about like Shadow and Substance, which is another way of saying that the cost of doing any given job can seldom be estimated from a price list alone. Unit ratings are just as essential for cost estimation as unit prices. It is unfortunate, therefore, that it is not always possible at present to correlate prices and capacities, and thus attain costs; and to that extent reference to this symposium as one on process equipment costs may be slightly misleading. What is meant is that the expert, using his own information on specific performance, can apply prices in the estimation of cost. Furthermore, with ingenuity he can often extrapolate related experience of his own or of others to predetermine costs with reasonable accuracy in cases where data on strictly comparable situations do not exist.

Another matter that this symposium cannot hope to answer is the question of equipment selection. Nor should price ordinarily be a basis for selection, or for a choice between products of competing manufacturers. In themselves small price differences are of no particular significance; large differences are indicative on the other hand of differences that may not appear at first glance. In fact there is some evidence, as pointed out by Arnold Weisselberg of the Wyssmont Co., that even in so diverse an equipment field as dryers, costs (but not prices) tend to become practically identical when dryers of different type are designed for the same service. There are good economic reasons why this should be the case to a large extent with all classes of equipment. It gives point to the belief that cost-performance correlations are theoretically possible, making efforts toward the development of such correlations both worthwhile and reasonably certain of success.

Precision Not Needed

The fact that equipment ratings of this kind may not be entirely accurate is not a particularly serious matter in preconstruction cost estimating. In fact, it cannot be expected that they will be highly accurate since small changes in process or in operating conditions often result in large changes in throughput, which cannot possibly be predicted in nominal ratings. Ratings that are in error will not cause disaster in the pilot plant stage, since that is the pilot plant's function—to determine data of unpredictable character. Project engineers no more expect to design a final plant without test and pilot plant data than an airplane manufacturer contemplates new models without prototypes.

Unfortunately, this recording of equipment costs in terms of cost per unit of output has little present background. This comes largely from the general feeling on the part of equipment manufacturers and estimators alike that the matter is outside the field of direct scientific approach—an art to be acquired intuitively, through experience. Manufacturers often point out, for example, that equipment involves so many variables that worthwhile unit cost generalizations are impossible. This attitude ignores the fact that equipment is, or should be, designed for maximum overall economy, which automatically eliminates some variables, and narrows down and permits the combination of others.

A case in point is heat exchangers, usually a relatively simple sort of equipment. For a typical heat exchanger in which no change in state takes place—and where inertia and viscous forces of the fluids predominate—there are no less than 21 prime variables in addition to the specification factors that determine type of unit, and the variable cost factors that set the monetary value. Obviously analysis cannot be made by means of these variables, for if each prime variable were allowed only two values there would be over 2 million items in the compilation for each type of exchanger.

Specifying the fluids reduces the variables to 13, but the further specification of maximum economy in fluids consumption, pressure drop, construction materials and maintenance reduces the variables to four: capacity, inlet and outlet temperatures for one medium, and pressure rating. Sometimes both pressure and temperature are also invariable, leaving only capacity as a variable quantity. This is admittedly an over-simplification, but it is often used for rough estimation of simpler forms of heat transfer devices. A more general method of rating is by type, area of active surface, pressure rating, and materials of construction.

There appears to be no good reason why ratings for other types of process equipment cannot be secured by synthesizing the many prime variables into a few characteristic variables applying to specific applications in the normal, economical operating range.

To some extent this has already been done, as certain of the data in this issue will show. Where only prices are available, however, the estimator will have to proceed as best he can, with or without the assistance of the project engineer. Manufacturers, for instance, can often give valuable advice on specific applications, while catalogs will sometimes fill in the gaps. In the latter case, however, the estimator should bear in mind that optimism aimed at averting unfavorable comparisons may have gone into their compilation, leaving to him the problem of chosing conservative factors of safety.

Indexes in the Plant Cost Picture

EDITORIAL STAFF

IF COST DATA on process equipment are to be used with sufficient reliability for preconstruction cost estimating, they must either be relatively "fresh"—or means must be obtained for keeping them approximately up-to-date. Such data are a highly perishable commodity as every engineer who deals with estimates knows. Not only do they vary with the broad swings of the business cycle, but data on individual pieces of equipment also vary in more or less unrelated fashion, dependent to some extent no doubt on the relations between—and cost of—various kinds of labor and various sorts of materials that are required.

On top of such relatively predictable variations, however, are other factors dependent on competitive conditions, the tax situation, relation of demand to production capacity (i.e., the state of the backlog of unfilled orders), labor efficiency, mass psychology, and business optimism. Just as with other branches of economics, equipment pricing is not an exact science and its fluctuations usually can not be reduced to formula. Some evidence of this unpredictability will be noted in the divergent characteristics visible in Fig. 1.

Needed: an Index . . .

An answer to equipment cost variations, as in other measurable economic data, may lie in index number series. Many series having some bearing on equipment costs are available, particularly those published by the U. S. Department of Commerce in the monthly *Survey of Current Business*. Many individual raw materials and finished commodities are price-indexed in this fashion, while the same compilation includes wage rates in various industries and classifications, as well as numerous activity indicators. A considerable number of private agencies also issue index number series at regular intervals, several of which are reprinted in the *Survey*. Some of the series of interest in connection with process plants and equipment are those on costs of pig iron, steel, building materials, common nonferrous metals, certain kinds of machinery, as well as building and construction costs.

Unfortunately, the estimator who attempts to apply these data to the direct determination of changes in process equipment costs is faced with the discovery that few are applicable in this way. To a considerable extent the ingredients of labor and materials are there, but they can not be extrapolated to finished equipment. For construction operations the way is clear, since there are some dozen well-known and successful building and construction cost indexes. But equipment fabrication costs follow no uniform and well defined trends. Something further is needed.

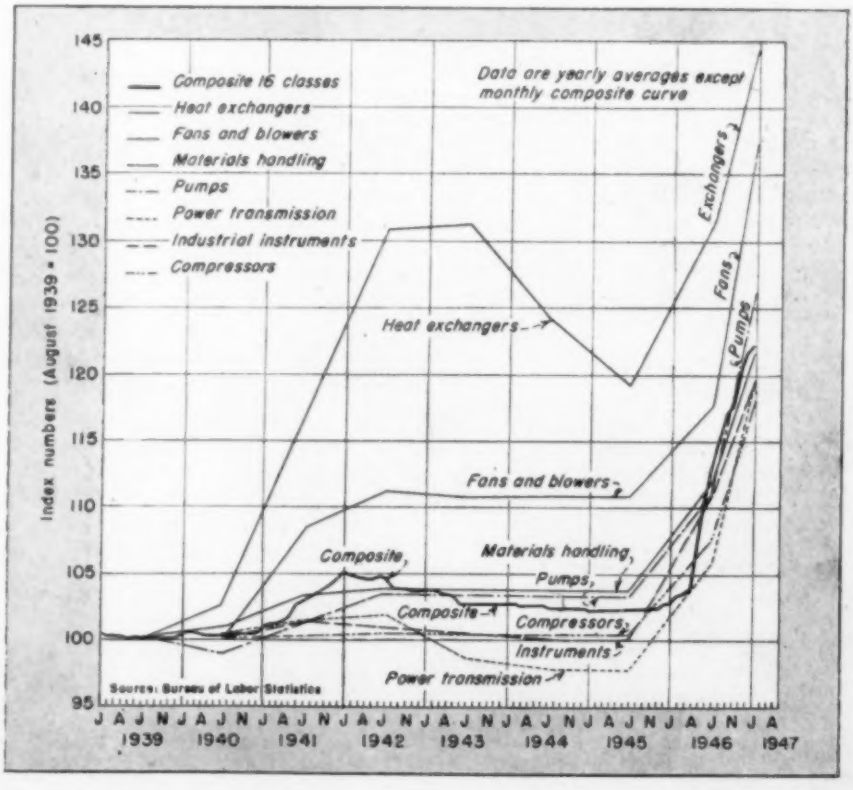
When the current program on process equipment costs was being planned, the editors of *Chemical Engineering* considered the need for a process equipment cost index, or indexes, and found nothing available. Furthermore, a study of typical equipment cost variations in the past showed that no single cost indicator could index the variations of even the main equipment types with acceptable accuracy, owing to individual vagaries.

. . . For Complete Plants

However, a hopeful aspect of the situation was the discovery of the more or less predictable fact that large and varied samples tend to iron out individual irregularities. With reasonable accuracy it was found from a few available time-cost curves for complete process plants that such curves tend to fall within about 5 to 10 percent of an average, as shown by the "plant cost" curve of Fig. 2.

Admittedly this curve was derived from too few data to provide final proof of the existence of the "law"

Fig. 1—Bureau of Labor Statistics Composite equipment cost index curve and curves for seven selected kinds of equipment used in process plants



just stated but it appears reasonable and for tentative use offers interesting possibilities in furnishing a pattern for a complete plant cost index. Doubtless highly specialized plants, particularly those that lean heavily on one or a few kinds of equipment, will not follow it closely. It may not represent the facts well for small plants that do not constitute "large samples." But for medium to large plants with a good variety of both specialized and standard industrial equipment, present evidence seems to show that it offers a fairly accurate picture.

In theory, if such a curve represents a reliable cost index curve for complete process plants in the past, then another curve for the same period which can be derived from known data, and which parallels it closely, should continue to parallel it in the future if conditions do not vary too much. Widespread technologic change, for example, might constitute too great a variation. The curve has been used in this way in the attempt to build a closely parallel curve from various combinations of known data—which will also be available in the future. Most of these attempts were not successful although one combination appears to offer fair agreement and is therefore suggested tentatively for future use, pending the securing of more proof data, and further study and improvement.

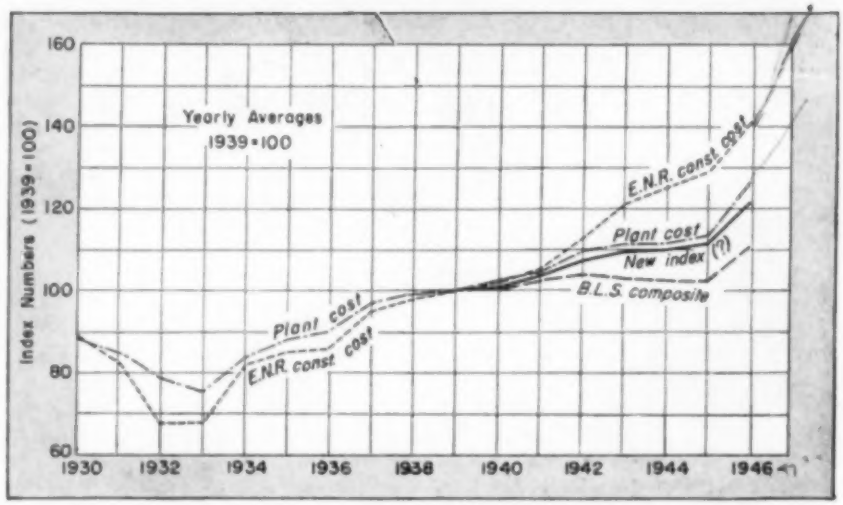


Fig. 2—Plant cost average curve compared with *ENR* and BLS Composite index curves and tentative new complete plant index

Table II—Comparison of Cost Indexes, 1939-1947

Year	ENR Index	BLS Index	Plant Cost Avg.	New Plant Cost Index
1939.....	100.0	100.0	100	100
1940.....	102.7	100.2	102	101
1941.....	109.4	102.6	105	105
1942.....	117.3	104.3	110	109
1943.....	123.1	103.1	111	110
1944.....	126.8	102.5	112	111
1945.....	130.6	102.4	113	112
1946 Avg.....	146.9	111.4	127	123
1947 Jan.....	162.1	122.3	146	136*

*Fails to show low labor productivity?

Construction Cost Index

It is an interesting fact that many estimators have come independently to the conclusion that the Construction Cost Index published monthly by *Engineering News-Record* (also reprinted in the *Survey of Current Business*), can be used for the rough "factoring" of equipment cost data from one date to another. This fact is brought out by Happel, Aries and Borns (*Chem. Eng.*, 53, 99, Oct. 1946) and confirmed by discussions with estimators. This index is synthetic in nature, being the theoretical cost of a certain amount of average construction determined by adding together the costs of 25 cwt. of building steel, 1,088 bf. of a particular size and grade of lumber, 6 bbl. of cement, and 200 man-hours of common labor. In the base year of 1913 this certain amount of construction cost $100. In April 1947 it cost $396.09. Intended to reflect average construction costs, it bears no particular relation to the cost of equipment and yet it does a surprisingly good job for complete plants as the 1930-'46 data of Fig. 2 show. For the purposes of this chart the *ENR* Index has been recalculated to a 1939 base, a year for which its average was 235.51.

This index is strongly weighted in favor of common labor which appears in part to explain its departure from the Plant Cost curve in 1930-'33 and again in 1942-'47. Common labor rates fell more rapidly than most other indicators in the earlier period, and rose more quickly in the later period. It appeared therefore that "dilution" of the *ENR* Index might be one way of approaching a plant cost index.

Indexes for Machinery

Since 1939 the U. S. Department of Labor, through its Bureau of Labor Statistics, has issued quarterly its "Index Numbers of Prices of General and Auxiliary Machinery and Equipment," which includes a total of 143 kinds of equipment in the general-purpose category. These are grouped in 52 sub-groups and 16 main divisions. Composite indexes are presented for

Table I—Index Numbers of 16 Classes of General Machinery and Equipment

(Source, Bureau of Labor Statistics, Aug. 1939 = 100)

Equipment Class	Number of Items in Composite	1939	1940	1941	1942	1943	1944	1945	1946	Jan. 1947
Overall composite	143	100.1	100.3	102.6	104.3	103.1	102.5	102.4	111.4	122.3
Compressors	4	100.0	100.1	100.4	100.5	100.4	100.4	100.4	107.7	117.8
Pumps	5	100.3	98.9	101.2	103.4	103.4	103.3	103.3	110.8	126.0
Ind. instruments	8	100.0	100.0	101.3	100.9	100.5	100.1	100.1	110.8	119.0
Matl. handling	20	100.1	100.9	103.3	103.8	103.6	103.6	103.7	112.1	121.3
Fans, blowers	2	100.7	99.9	108.4	111.2	110.8	110.9	110.9	117.8	136.5
Heat exchangers	2	100.0	102.7	117.0	130.9	131.3	124.3	119.4	131.5	144.7
Power trans.	24	100.1	100.3	101.4	101.9	98.6	97.8	97.9	105.9	118.6
Engines	8	100.0	100.1	102.6	106.1	106.1	107.2	107.3	117.8	126.5
Ind. stokers	3	100.0	101.7	103.2	104.3	103.8	103.5	103.5	119.4	140.6
Ind. oil burners	2	100.0	100.0	101.2	103.0	103.0	103.0	103.0	112.3	124.6
Welding, cutting	10	100.0	100.0	100.0	100.0	100.0	100.0	99.9	104.0	107.8
Lubrication	5	100.0	100.0	99.6	99.4	99.4	99.4	100.1	108.9	118.2
Ind. scales	7	100.0	100.1	104.6	107.6	107.6	107.6	107.6	124.9	135.7
Ht. tr. furnaces	6	100.0	100.0	101.2	103.0	103.0	101.5	101.4	110.7	116.9
Cutting tools	23	100.0	100.0	100.2	100.4	100.2	100.0	100.0	111.0	117.3
Mech. test inst.	13	100.0	100.9	105.7	109.6	108.9	109.1	109.2	118.0	123.9

sub-groups, main divisions and for the entire 143 elements. Although the machinery and tools represented are largely of industry-wide character and not specialized, most of the main groups are important in the process picture, as is evident from the overall and main division composites presented in Table I. Curves for the weighted overall composite and the first seven of the divisions are plotted in Fig. 1.

Basis of New Index

When the overall composite yearly averages (based on 1939 = 100) were plotted on Fig. 2, it immediately became evident that the *ENR* and Composite curves bracketed the Plant Cost curve in a rather regular manner. Certainly, complete plants involve costs of both construction type and of equipment type. Roughly, it may be considered that land improvement and building construction, usually averaging about 25 percent of equipment costs, and equipment installation, also roughly 25 percent of equipment on the average, are construction type operations.

Clearly, then, of each $150 spent for total plant, roughly ⅔ or $100 is for equipment type expenditures, and ⅓ or $50 for construction type expenditures, giving a basis for a weighted averaging of the *ENR* and Composite curves. With both on the same base each represents $100 of expenditure in 1939. Then, assuming a constant ratio of ⅓ construction type expenditures and ⅔ equipment type expenditures the two indexes are split in the same proportions for each year and the results added to give the new index curve marked "?" on Fig. 2. The data are tabulated in Table II. It will be observed that the new curve follows the Plant Cost curve within 5 percent or less, except for the last point (7 percent low). It has the advantage that it can readily be continued in the future, and pending improvements in it, will be periodically revised and presented in this magazine. If used with reservations it probably can be applied with reasonable assurance at present, but its further proof must wait on a great deal more evidence than is now available. This proof the editors hope in the future to establish. Meanwhile all those who are interested are cordially urged to offer constructive criticism, suggestions for improvement, and data bearing on the proof or disproof of this index series.

It must be emphasized, of course, that this index is based on national averages and therefore is not regional in character. Unfortunately, regional differences tend to invalidate national cost indexes. In the study by Happel, Aries and Borns already mentioned a table of location factors was presented, calculated from the 20-cities data regularly published by *Engineering News-Record* by weighting the relative costs of structural steel, steel plates, pipe, cement, lumber, skilled and common labor for typical petroleum processing plants. These factors, which show that high material costs are frequently offset by low labor costs, should be reasonably accurate for other types of process plants and should not have changed a great deal since their original compilation in Summer 1946. They are therefore reprinted in Table III.

Table III—Relative Total Plant Costs by Regions, Summer 1946

(Chicago = 1.000)

Boston	1.015
New York	1.055
Philadelphia	0.992
Detroit	0.984
Chicago	1.000
St. Louis	1.020
Kansas City	1.007
Dallas	0.971
Los Angeles	1.109

After Happel, Aries and Borns.

Buildings Costs

At the present stage it is extremely difficult to predict the cost of buildings for chemical plants by any method other than an actual detailed estimate, based on local conditions at the point where the construction is to be undertaken. Among the reasons for this difficulty are sharp but uneven increases in materials costs, which are by no means uniform in various regions, sharp increases in both skilled and common labor wages rates, which again are non-uniform; relatively low labor productivity compared with the pre-war period; and delays and substitutions caused by materials shortages. Regarding wage rates, *Engineering News-Record* finds common labor variations of as much as $0.80 to $1.25 per hour in the same city, and differences as great as $0.65 to $1.375 per hour between cities. In the skilled trades variations between cities at present are even greater, among carpenters ranging from a low of $1.06 to a high of $2.10, the latter for a seven-hour day.

Reduction Coming?

Writing in the April 17 issue of *Engineering News-Record*, E. W. Bowden of Walter Kidde Constructors, Inc., New York, states that industrial building cost reductions, estimated at 9 to 16 percent by one method, and at 13 to 17 percent by another method, may be expected in the near future. This will not come about by reduction in wage levels, but by the elimination of excess costs due to labor and materials shortages, low productivity, overtime wages and extraordinary contingency items. Basing one method on the analysis of actual cost to construct a typical one-story industrial building —which in 1939 could be built for $3 per sq.ft.—and comparing the actual cost curve in the intervening years with the theoretical increase in cost as measured by the *ENR* Construction Cost Index, he finds that the difference at present represents about 13 to 17 percent of the total, all waste expense.

Productivity Improving?

In regard to construction labor productivity, *Engineering News-Record* finds that although a slight improvement was shown during the past year, the country-wide average level with respect to 1939 still stands at only 66 percent for skilled and 75 percent for common labor. Differences are considerable however at various points, ranging for skilled labor from a low of 58 percent in Cleveland to a high of 80 percent in Los Angeles; and for common labor, from a low of 62 percent in Cleveland and Philadelphia to a high of 100 percent (i.e., equal to 1939) in Dallas.

It has been stated recently that factory space costing $4 to $5 before the war now costs about $9 a square foot, whereas the experience of one well-known manufacturer is that buildings costing $3 per square foot in 1938 would today cost $10 to reproduce. The H. K. Ferguson Co. estimates that conventionally designed industrial structures today run from $5 to $7 per square foot, but through economies in construction methods and simplicity in design and erection it is possible even today to put up a steel-frame, fire-resistant building of 250,000 sq.ft. or more area, designed for light manufacturing, for about $3 per square foot under ideal site conditions. Such a building, complete with all normal services within the building, is said not to sacrifice desirable features required for low maintenance or satisfactory production layouts. This price, however, is a minimum which cannot be attained for many purposes.

Unit Cost of Some Complete Plants

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Costs will vary widely for the construction of plants to produce the same chemical, depending upon: (1) The process used and size of the installation; (2) whether the plant is at a new location, or is an expansion of present operations, or is for a new product in an existing plant having adequate utilities; (3) the geographical location; (4) degree of safety practiced by the company; (5) permanency desired; (6) local polution problems; and (7) labor and material costs. There are in addition a number of secondary problems.

Therefore, while it is exceedingly dangerous to use any over-all cost figures for preparing estimates, a study has been made of a number of plants built during 1942-1944 in order to present some sort of over-all estimating factor for chemical plants.

In the adjacent table the approximate cost of plants is given on the basis of the annual production in tons per year (except in the cases of gases, which are based on thousands of cubic feet per year, and penicillin, which is based on millions of units per year). The year of construction is given so that allowance can be made for variations in year to year construction costs, and the number of plants on which the data are based is indicated. Under "Class" plants are given three general types:

A—Expansion of existing facilities.
B—New facilities in existing plant. New building and equipment, but taking advantage of plant utilities and other services.
C—Entire new facility at new location.

The distinction between these three general types is considered quite important. The cost of construction at a new location is far higher than in an existing plant; whereas expansion of existing facilities is far cheaper. Most of the data are based upon plants actually built, although a few are based upon estimated costs.

As an example: A chlorine plant in a new location, complete with power generation and producing 30,000 tons per year would be expected to cost 30,000 × 205, or on the order of $6,150,000 based on construction costs prevailing in 1942 and 1943.

Approximate Unit Costs of Chemical Plant Construction

Product for Which Plant Was Built	Plant Cost, Dollars per Ton per Yr.	Class	Year	No. of Plants
Inorganic Chemicals				
Ammonia, synthetic from natural gas	130	C	1943	1
Ammonia, synthetic	86	A	1942	2
Carbon bisulphide	54	C	1944	2
Carbon black	39	A, B, C	1943	7
Calcium carbide	44	C	1944	2
Chlorine, including steam and electricity generation	205	C	1942–3	1
Hydrogen	5*	B	1943	2
Hydrofluoric acid, anhydrous	125	C	1944	1
Oxygen, for supplying liquid oxygen	5*	C	1942	2
Oxygen, addition for supplying gaseous oxygen	1.8*	A	1943	5
Potassium perchlorate	450	B	1943–4	1
Phosphorus	300	C	1943	1
Phosphorus	83	A	1944	1
Phosphorus	118	B	1944	1
Nitric acid	91	B	1944	1
Sulphur recovery, recovery from H_2S	7	C	1943	1
Sodium, metallic	220	A	1944	2
Superphosphate	6.2	B	1944	3
Superphosphate	18.7	C	1944	1
Soda ash	25	A	1942–3	1
Sulphuric acid	9.5	A	1942	8
Sulphuric acid	11	B	1942	1
Sulphuric acid	15	C	1942	3
Plastics				
Methyl methacrylate, polymer and monomer	420	B	1943	2
Melamine	108	A	1943	1
Neoprene, very large scale	910	C	1942–3	1
Nylon, flake	530	A	1942	1
Polyisobutylene	830	A	1943	1
Polyvinyl chloride, polymerization only	124	A	1943	1
Phenol-formaldehyde resin	128	A	1943	1
Polyvinyl chloride, polymer and monomer	1,000	B	1943	1
Phenolic molding powders	49	A	1943	1
Styrene	300	C	1943	4
Styrene	116	B	1943	1
Vinyl chloride, monomer	858	A	1943	1
Vinylidene chloride	385	A	1944	1
Organic Chemicals				
Acrylonitrile	144	A	1943	2
Allyl alcohol	1,580	B	1944–5	1
Activated charcoal	72	A	1944	1
Alkyl amines	137	B	1943	1
Benzaldehyde	484	A	1944	1
Benzil	232	A	1944	1
Detergents, synthetic	265	A	1944	2
DDT	260	B	1944	4
Dibutyl phthalate	69	B	1942	1
Ethyl cellulose	408	1	1944	2
Ethylene	85	A, B	1944	2
Ethylene dibromide	340	A	1944	1
Freon	220	A	1944	1
Furfural	190	C	1943	1
Gasoline gum inhibitors	580	A	1944	2
Methyl isobutyl ketone	33	B	1944	1
Mercaptan	147	B	1943	1
Maleic anhydride	180	A	1943	1
Nicotinic acid	1,840	A	1944	1
Phthalate esters	54	A	1944	1
Phthalic anhydride	128	A	1944	1
Phthalic anhydride	190	B	1944	1
Penicillin, deep fermentation, based on rated capacity, but this greatly exceeded	2,900†	C	1944	2
Phenol, sulphuric acid process	200	C	1943	1
Phenol, chlorination process including Cl_2 cells	240	C	1943	1
Phenol, sulphuric acid process	66	A	1943	1
Silicone resins	1,500	B	1944	1
Salicylic acid	250	A	1943	1
Toluene	250	B	1944	1
Alcohol and Solvents				
Acetic acid, by oxidation of alcohol	134	B	1942	1
Acetone	30	A	1944	1
Acetone	80	B	1943	1
Ethyl alcohol, fermentation of grain	62	C	1944	3
Ethyl alcohol, from wood waste	165	C	1944	1
Ethyl alcohol and isopropyl alcohol, from ethylene and from propylene, combination unit	70	B	1942	1

* Dollars per 1,000 cu. ft. per yr. † Dollars per million units per year.

Plant Design for Minimum Cost

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ASSISTANCE TO the chemical engineer or executive confronted with the basic problems of building layout and costs is the sole purpose of this article. Whether the project is a new plant or an addition to an existing plant, he may be called upon for decisions on the site, and the number, type and layout of the buildings. He may even be asked to estimate the cost of the structures involved.

In these procedures, he is like a civil engineer attempting to lay out and estimate the cost of a new chemical process—a task which no one without related technical training and long experience would want to undertake.

Of the chemical engineer's two problems: (1) The selection of the site, and the form and type of structure; and (2) estimating the cost, the first is by far the more important. Often by the time a chemical plant is turned over to the designing engineers, the buildings are so completely tied into the intricate process layout that it is not practicable to make major changes, with the result that the chemical engineer's building layout is retained. Therefore he has made all the *major* decisions—decisions that may have as much as a 100 percent affect on building costs.

Obviously these are important responsibilities for the chemical engineer. Whereas an erroneous estimate has no affect on the *actual* cost and can be corrected at any time before the work is started, any avoidable building costs are preserved in steel and masonry as a permanent handicap to low-cost operation.

Therefore to be of maximum service to the chemical engineer and executive, this article deals primarily with his biggest task—plant and building layout to give minimum costs. This problem is so large that only basic factors can be covered in this article, but these are the factors that exercise major control over the final costs.

Examples selected to illustrate the influence of certain factors on costs may not be particularly related to specific chemical industry requirements, but they reflect concrete problems applicable to some extent to all industries. Although they cannot be used in any general sense for estimating, they indicate certain fundamental qualitative relationships which will be just as valid in 10 or 20 years as they are now.

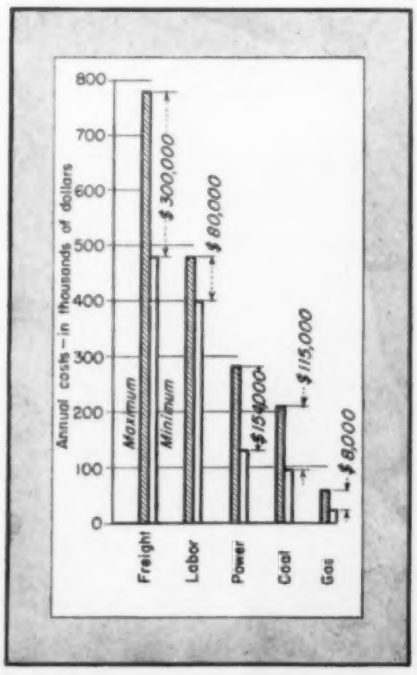
The factors discussed here are presented in the order in which they must be faced: (1) Plant location, (2) basic plant planning, (3) building layout, (4) building services and facilities, (5) estimating the costs and (6) the final question—is it worth the price? There is only one theme throughout: how to secure minimum building costs.

The Basic Cost Factor

Successful plant planning requires broad vision by management. Because many new plants will be the nucleus for large future expansion, this broad vision is particularly important in the first step of planning a new plant: selecting its site.

It may even be desirable to review the suitability of an existing site whenever a major expansion program is under consideration. A location which was advantageous 20 years ago may now be a competitive—or economic—handicap. There are a number of instances of firms moving from a plant, still worth millions of dollars, to a new location, because a complete analysis showed it to be the most profitable decision they could make.

Fig. 1—Variations in selected operating costs for a specific chemical plant as affected by the plant's location



Determination of the best plant location involves two steps; an analysis to fix the general locality; and the selection of the specific site.

The first step is of special importance to chemical plants since the choice of the general locality may have a marked effect on such costs as fuel, power, water and freight—all major operating costs. A forceful illustration is provided by one of our plant location surveys.

This survey was to determine the proper location for a new chemical plant, in an assigned area including six states. An analysis of the operating costs showed that only six items varied appreciably for different locations within these six states: freight, labor, power, coal, gas and taxes. A discussion of taxes is outside the scope of this article but the ranges of annual costs for the other five items are shown in Fig. 1. For example, the annual freight bill could be anything between $480,000 and $780,000—dependent solely upon the location of the plant.

Since all items were not a minimum at any one location, the analysis determined the location which gave the minimum *total*. The importance of proper plant location is indicated by the fact that, for the case shown in Fig. 1, the choice of locality alone could give a variation in operating costs of $400,000 every year, or $800,000 per year if the plant production should be doubled.

After the general location of the plant has been determined, the choice of the specific site may also greatly affect costs, and again this decision is often made without full appreciation of its importance. General grading, soil conditions, side tracks, utility connections, water supply and treatment, sewage and waste disposal, are some of the factors which vary with the choice of site.

The effect of different foundation conditions on the construction cost of

the industrial building shown in Fig. 2 illustrates this point.* Note that in many instances these buildings might contain large pits or trenches, or heavy equipment with individual foundations—all of which would also cost more for cases *B*1, *B*2 or *B*3, than for *B*.

While operational needs may sometime require that a plant be built where expensive foundations—or long utility connections, or water treatment—are necessary, the decision on the site selection should be based on a complete cost analysis, remembering that all future expansion will be similarly affected.

Minimum Cost Planning

Having selected the proper location and site, the next decisions affecting building costs are the considerations involving the number of buildings and the number of stories. Here the fundamental approach should be that of over-all economy, with the efficiency of the process, manufacturing operations, or other function taking precedence over first cost.

However, equally efficient operation may be possible with a number of layouts—some of which will permit minimum building costs, while others would needlessly increase these costs. Thus, although sound economic reasons may often dictate a functional layout that will require an expensive building, the important point is to avoid these higher costs if they contribute nothing to operational efficiency.

Recognition of certain basic principles of building layout can help the chemical engineer in making judicious decisions. The fundamental principle is simple: to secure minimum total building costs (amortized first cost, plus maintenance, plus operating cost of building services) the total required plant floor area should be provided in the minimum number of buildings and with the minimum number of floors. The obvious ultimate preference is one single-story building.

As an example, Fig. 3 shows three ways of providing a total of 96,000 sq.ft.: four single-story buildings, one single-story building, one four-story building. The comparative cost percentages† are rather striking but, at that, they tell only part of the story. The 96,000 sq.ft. of each layout is gross area, so that if deductions are made for loss of working space occupied by exterior walls and columns, and for the elevators and stairways in the multi-story structure, the net floor area (productive area) and the proportional cost per square foot of net area are:

	Net Floor Area, Sq. Ft.	Cost per Net Floor Area, Percent
D	92,375	116
E	93,800	100
F	87,760	146

Furthermore the multi-story structure will have other handicaps: maintenance and operational expenses for its elevators; greater costs for pits or special machinery foundations; far less flexibility for expansion or for possible changes in production layout.

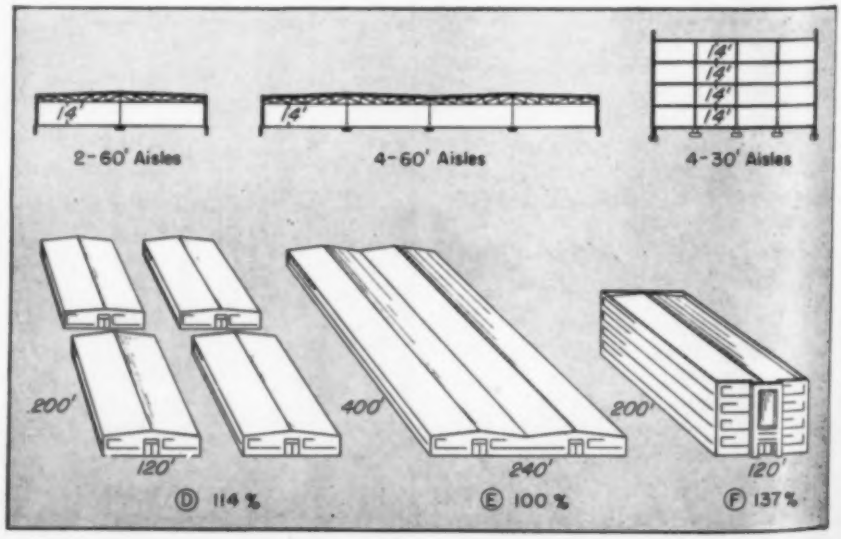
Certain industries have been particularly slow to realize the basic advantages of single-story buildings. One reason has been because of the gravity flow of materials which is possible in multi-story buildings—where the cost of first lifting such materials to the upper floors is easily overlooked. Another reason given for multi-story buildings has been high land values, but (to refer again to the specific cases in Fig. 3) to justify the higher cost of building *F* compared to *E*, the land would have to be priced at more than $100,000 per acre.

The section above sets forth principles of plant planning for minimum cost, while this section deals with building layout for minimum cost. It is common knowledge that a long, narrow building costs more, due to increase in wall area, than one nearly square in plan. For example a building 80 × 500 ft. costs about 5 percent more than the 120 × 200 ft. building *B* of Fig. 4. Some variations of physical proportions which affect cost are clear height, column spacing, floor level and inclusion of basement or mezzanines.

A choice of clear heights providing ample room for changes in equipment or occupancy, and providing space and supports for maximum flexibility in the location of monorails and conveyors, will prove to be economical. Small increases in height add little to first cost, but bulk large if necessary at some future time. A 1-ft. increase in the height of building *B*, Fig. 4, adds only about 2 percent to the original cost. Fig. 5 shows that flat roofs cost less than roofs having sawteeth or monitors. Occasionally clearances for cranes or high equipment require a structure having aisles whose clear heights vary considerably, making monitors economical; however, such a choice is more often predicated upon requirements for light and ventilation.

Functional layout is the most important consideration in selecting an economical column spacing. In choosing this spacing, consideration should be given to adequate clearance for equipment maintenance, and to the desirability of providing space which is flexible. Fewer columns provide more flexibility, and less waste space. Fig. 4 shows comparative costs for various column spacings of a typical 120 × 200 ft. building with 20-ft. bays. The spacings of *BJ* or *CJ* provide greater clear floor areas with only a small increase

Fig. 3—Comparative construction costs for the same gross floor areas as provided by three different plant layouts



* In Figs. 2, 4 and 5, the percentages given are comparative first costs for the simple buildings shown, without manufacturing equipment. All these buildings are 120 ft. wide x 200 ft. long with brick and steel sash walls, bonded concrete floors, steel frame and concrete tile roof with 20-year-roofing. The costs include design and construction, with normal fees and builder's profit, a heating system, fluorescent lighting, sprinklers, roof drainage and plumbing, with a toilet and wash room for 100 men. No boiler is included, nor any work outside the building such as utility connections.

† Again the percentages are comparative first costs for complete buildings, without manufacturing equipment. The four-story building has a structural steel frame (not fireproofed), concrete floors designed for a 225 lb. per sq.ft. live load, two stairways, a passenger elevator and a freight elevator.

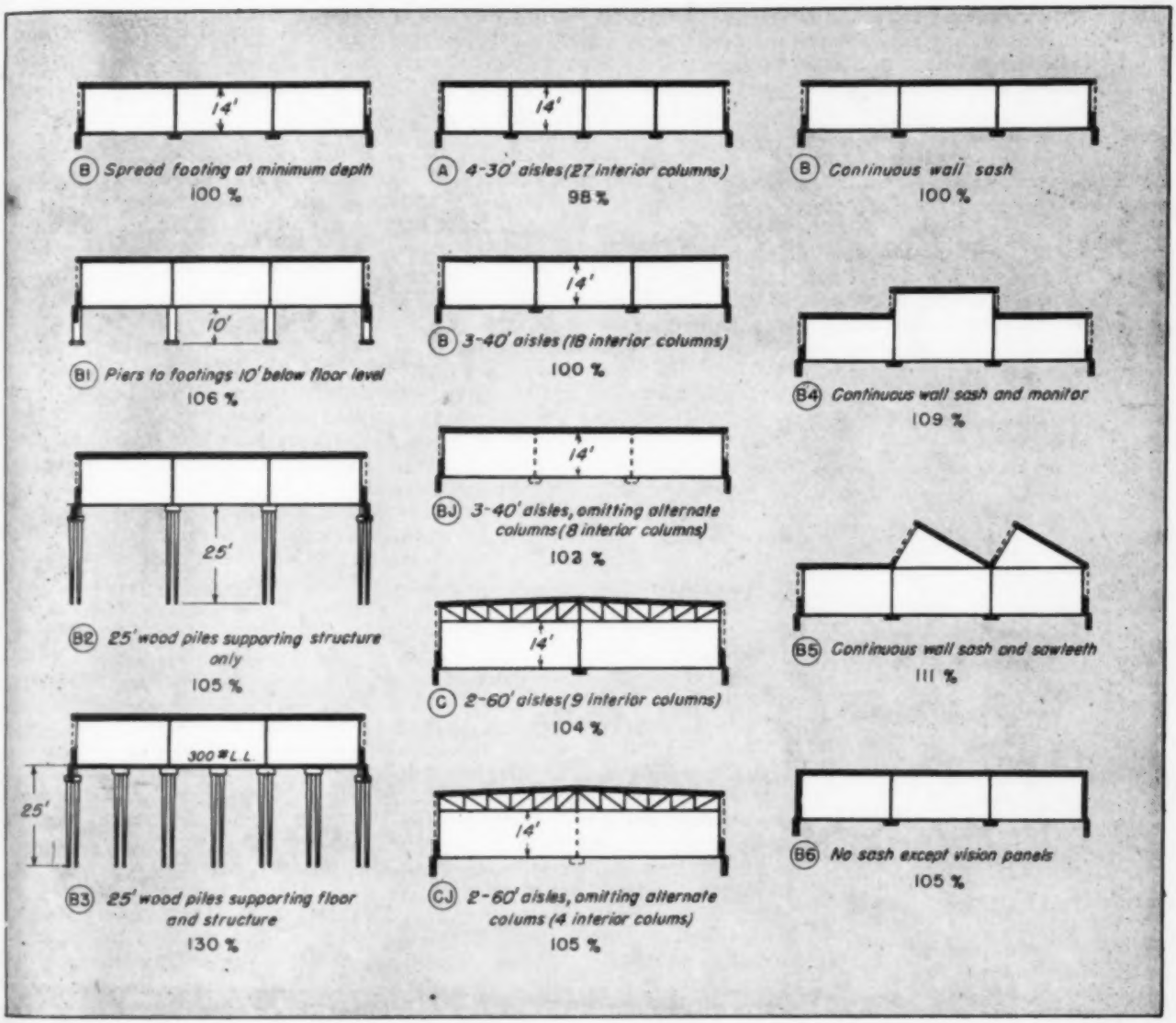


Fig. 2—Comparative construction costs for a specific building as affected by variations in foundation conditions

Fig. 4—Comparative construction costs for similar buildings as affected by the number of interior columns

Fig. 5—Comparative construction costs for similar buildings as affected by variations in fenestration and roof structure

in first cost, no increase in maintenance cost, and frequently with substantial operational savings due to the increased flexibility.

Unless the topography of the site is such as to reduce excavation to a minimum, basements are rarely justified in view of their additional cost. A basic exception to this statement is for the many process plants requiring extensive piping and services to numerous pieces of equipment. In these cases, basements with a minimum of head room, a minimum expenditure for the floor, and with as many posts as are needed to support the working area economically, reduce the costs of installation and maintenance of such services to a minimum.

Mezzanines provide an economical means of increasing floor space and removing auxiliary activities and equipment from the production floor. They are often used for supervisory offices, toilet and locker rooms, cafeterias, electrical sub-stations, air-conditioning and other equipment rooms.

Building Service Facilities

Recent development of techniques and equipment for complete control of operating conditions in industrial plants now make it important to determine the required extent of building services at the very outset of the planning. The type, amount, and degree of control of the lighting, heating, ventilation, air-conditioning, and sound conditioning should be decided upon before the building layout is considered, if minimum costs are to be obtained.

Inter-relation of these services makes it difficult to generalize on the relative costs entailed in providing various amounts and various degrees of control. An example may best illustrate the problem.

Comparative costs are given in Fig. 5 for four buildings each meeting the same standard for artificial lighting and heating. Although building *B* would be suitable for such functions as warehousing, building *B4* would be preferred for most manufacturing operations as it provides better daylighting and natural ventilation. Building *B5* is an alternate manufacturing cross-section where directional daylighting is desirable.

If precise control of the operating conditions is required, no one of the previous buildings is suitable: lighting varies over a wide range due to the influx of daylight, heating will be af-

fected by the large sash areas (both by solar radiation and simple transmission), ventilation will vary with temperature differentials, wind direction and velocity.

Obviously, in any plant requiring complete and uniform control of conditions, air-conditioning is also necessary. In such cases, the flat-roofed, "windowless" cross-section *B6* has proven to be the most economical, not only in first cost, but also to operate. Double-glazed vision panels are frequently provided in the walls of such structures to overcome any possible psychological objections, without any effect on operating conditions.

Service Facilities

In planning toilets, locker rooms and other facilities for the service and convenience of employees, factors which have direct effect on operating and maintenance costs may be even more important than those governing initial costs. Proper layout and distribution of such facilities, for instance, may save enough of employees' time to offset any differential in initial costs, while selection of materials and equipment which require a minimum of janitorial services and maintenance will show corresponding economies.

First-aid and hospital facilities, required to keep pace with industrial safety programs, can be met economically with compact unit layouts using standardized hospital equipment. Substantial savings can be made by anticipating the need for private treatment rooms and multiple facilities at the outset.

Facilities for in-plant food service can be held to a minimum cost by careful planning and the adoption of staggered schedules. When it is advisable to provide large central cafeterias, the cost applicable to this use may be reduced by designing this facility for efficient alternate uses in employee training, recreational and community functions.

In office buildings and research laboratories, clear spans of 50 to 60 ft. permit a degree of flexibility which makes it possible to maintain efficient layouts in the face of changing needs. As in production areas, permanent walls are held to a minimum and removable partitions are installed wherever privacy is essential. The character of work and payroll represented by the occupancy of such buildings frequently makes it advisable to include air conditioning for maximum control of working conditions.

The wide range of service facilities normally required by chemical research and development laboratories can frequently be met at maximum economy by providing central pipe galleries and service trenches.

Building Costs

Having completed a plant layout to give minimum costs, the chemical engineer turns to the problem of predetermining construction costs.

There is no short cut in the preparation of an accurate cost estimate. The only recognized method is by a material and labor take-off, applying proper prices to these items, and including additional allowances for general conditions, insurance, job organization, overhead, weather and similar contingencies and a legitimate profit.

If computing building costs could be reduced to the procedure of a cost engineer in an industrial plant where relatively fixed conditions exist, the problem would be much simpler. When consideration is given to unforeseeable weather conditions such as wind, rain, snow or cold, all capable of causing untold expense and delay, it is evident that a great deal of experience and judgment is required in arriving at proper costs.

Many variables can affect labor costs. A mason will lay more brick on a warm day than on a day in which the temperature is near freezing. A tile setter will set more tile in a large rectangular room than in a small one having many offsets. No two superintendents handle men the same way, nor do contractors employ the same construction methods and equipment. When business is slow, good workmen are easily obtainable, but when it is booming, the opposite is true.

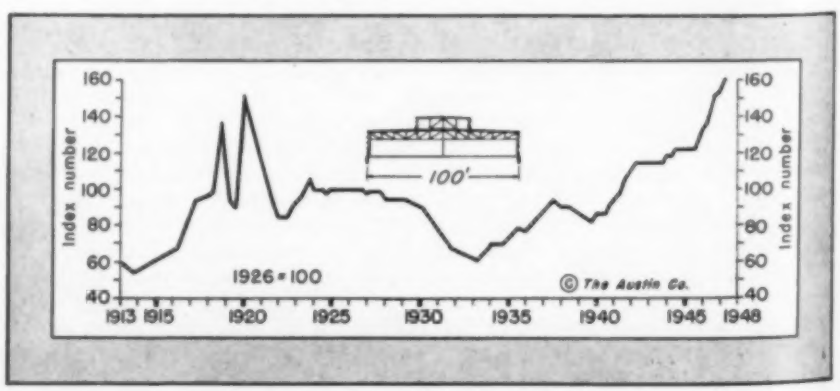
For comparative purposes, costs per square foot are often computed from detailed construction estimates, or from final cost summaries of completed contracts. However, the use of square-foot costs in the reverse order—for estimating—is not recommended, except for men qualified by training and long experience. Even for them the many variable conditions affecting cost present hazards.

The Austin Index for Industrial Building Costs, shown in Fig. 6, indicates the cost trend since 1913. In using any of the various available index curves to establish square-foot costs for a certain date, or a certain locality, extreme care must be taken to see that the curve fits the problem at hand. *Engineering News-Record* publishes monthly building and construction costs indexes, along with basic material prices and wage rates.* In its annual cost issue, it furnishes voluminous construction cost information for every section of the country, including building cost indexes for numerous types of buildings. However, even though square-foot costs are used from a building similar in every respect, and proper building cost indexes are selected to adjust those unit costs, an estimate prepared in such a manner may still be in error by a substantial amount.

Costs and Profits

In a plant construction or expansion program the final step is management's responsibility: the go-ahead signal. The present high building costs (see Fig. 6) make this a difficult decision in many cases. If a thorough analysis shows the construction to be nonessential at present, then it should be deferred. However, if it can be shown that the new investment will earn attractive profits, then the decision in most cases should be to go ahead. This is particularly true if the inflated portion of the first cost can be written off quickly in the current sellers' market, thus putting the concern in better position for the return of highly competitive conditions that undoubtedly are ahead.

Fig. 6—Austin Index of Industrial Building Costs



* However, it should be noted that most indexes fail to reflect changes in labor efficiency, or additional cost for delays in material deliveries or labor overtime.

Considerations in Industrial Plant Site Cost

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EVEN AT A TIME when prices are relatively stabilized it is difficult to generalize costs of preliminary site investigations, site preparation and the installation of basic utilities. In today's market it is even more difficult. There is no rule of thumb, unfortunately, that will enable the prospective chemical plant owner to determine his costs. However, a discussion of the factors involved can be helpful.

The most comprehensive figures on chemical plant costs developed on wartime, Government-financed installations disclosed that approximately 30 percent of the total cost of a given facility was accounted for in the selection and preparation of sites, the purchase of land, and the installation of basic utilities, including water, power, heat, steam, roads, railroads, parking areas, and the like.

Over-All Site Cost

A 30 percent average is perhaps a little high for chemical plants for private industry. One reason is that the particular survey that obtained the 30 percent figure took into consideration the many explosive plants which were scattered over thousands of acres for safety reasons. Safety distances, in addition to requiring more land, also require more roads and railroads, longer steam and power lines, and so on through the services and utilities.

Cost of land would be one of the principal influences on the relationship of cost of preliminary site work to the overall cost for a new plant. Some sites in highly industrialized areas—such as along waterfronts—would cost far more than a farmland site in a rural area.

But using the 30 percent wartime average as a basis, and discounting the vast areas often covered by Government munitions plants, it could be assumed that 20 to 25 percent of a chemical plant investment is accounted for in the selection and preparation of the site, the purchase of land, and the installation of basic utilities and services, including water, power lines, heat transmission lines, steam lines, roads, railroads, parking areas, fences and the like. This figure does not include steam distribution systems, electrical distribution systems or heating systems within the buildings. Nor does it include specialized types of plants. It does include such items as steam lines connecting the plant with the boiler house, the lines bringing electrical current from the source of supply to the buildings, and the like.

Site Search and Investigation

A search for a plant site involves the selection of a plot of ground best-suited to the production and distribution problems of any given manufacturer. It is a painstaking problem whose many ramifications cannot be overlooked; in many instances, it is the most significant step in the plant construction program. This is especially true in the chemical industries, because of their great dependence on such factors as sources of raw material, and power and water supply. When speaking of costs of searching for and investigating sites, one is challenged with a problem that can seldom cost too much—granted that the program is being directed competently.

The price range for this service depends entirely on how exhaustive the plant owner wants to make it. Sites without too specialized qualification can be found at relatively low cost—sometimes for less than $5,000. If highly specialized requirements are a factor, the cost can be many times more.

Survey and Purchase

Surveying a plant site is a negligible cost factor for the average peace-time chemical plant. Generally, sites are confined to 10 acres or less, and even the most detailed surveys can be completed within a week. On the other hand, surveys for some wartime chemical facilities accounted for very large expenditures because many plants required plant sites of thousands of acres.

Land purchase is a factor more in the realm of the real estate agent than in that of the industrial engineer and builder. It is, however, a factor of prime importance in the economics of any industrial operation. Land values vary according to location. In rural areas, land can be purchased for as little as $100 an acre; in industrialized areas costs run as high as $500 an acre.

Preparation and Landscaping

Preparation and grading of plant sites will be influenced by the terrain and the locality of the site. In hilly areas, site preparation is costly. The same is true if existing structures must be demolished. In reviewing several projects directed by our organization in recent months, we have determined that the cost of this part of a building project usually is slightly less than one-half of 1 percent of the total cost of the project in ordinary cases.

Plant landscaping cost may vary so greatly that it is hardly worthwhile to cite any figures. If elaborate landscaping is desired, experts are called in and even very small plots will require expenditures of many thousand dollars. If a grass covering is desired merely to keep dust from blowing into equipment and buildings, costs will be considerably less.

Roads and Parking

There is no way to determine the "average" requirements of a chemical plant in these categories, nor for such other items of the site as fences, wells, and sidings. It is, however, possible to mention a cost range which may have application to the individual case.

Parking areas, with a black top surface, generally range from $2.50 to $4 per square yard, depending on the terrain. A similar yardstick may be applied to roads.

Railroad sidings usually range from $8.50 to $10 per lineal foot in today's market. This figure includes grading, ballast, ties, track and an average number of switches.

Another consideration which may be counted on is fencing. The chain link type fence is almost standard. Its cost may be computed at the rate of $2 to $3 per foot, depending on the number of gates and on site conditions.

The cost for well facilities is not so easily determined. Many factors influence prices, including capacity, pressure, soil conditions and depth. A unit price, quoted by a leading well drilling organization is $1.50 per foot of 1-in. well. This figure translated into terms of plant requirements means that well drilling will cost from $8 to $40 per foot, exclusive of pumping facilities which also will vary greatly in price.

Estimating Cold Insulation Costs

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(Editor's Note—This article on cork insulation, the first of three by Mr. Otto on the estimation of various insulating materials, deals with cold and refrigerated pipelines and equipment. Data given here should not be used for building insulation, for sound-proofing or for shock isolation.)

BEFORE the engineer estimates the cost of an insulation job, he should make certain that the recommended thickness of the insulation is carefully checked and that the form and size of the insulation material is selected properly and fits the piping or the pieces of equipment involved. For design purposes it is necessary to obtain from the manufacturer of cork pipe covering the exact wall thickness because thickness varies with the different pipe diameters. As a check on necessary thickness, Table I shows thicknesses of cork insulation recommended for various temperatures and diameters of pipe or equipment. Cork insulation should not be used for temperatures above 100 deg. F.

For pipe insulation the following general rules apply:

1. "Special Thick Brine" pipe covering, hereafter abbreviated *STB*, should be used on cold lines operating at temperatures from zero to −25 deg. F., or where the surrounding temperature is unusually high.

2. "Brine Thickness" pipe covering, hereafter abbreviated *BT*, should be used for brine, ammonia, carbon dioxide, and other low temperature gas or liquid lines operating at temperatures from zero to 35 deg. F., or where the maximum temperature difference between gas or liquid and surrounding air is under 100 deg. F.

3. "Ice Water Thickness" pipe covering, hereafter abbreviated *IWT*, should be used on refrigerated lines operating at or above 35 deg. F.

Net vs. Discount

In estimating costs for cork insulation, certain facts should be kept clearly in mind:

1. Manufacturers quote all prices for (*a*) sectional pipe covering and (*b*) molded form pieces for valves, fittings, etc., as *list prices* subject to a discount.

2. However, prices for (*c*) cork lagging and (*d*) corkboard are *net*.

3. Prices are quoted f.o.b. certain industrial centers and the discounts vary according to the freight rates to such centers and to the quantities involved in individual purchases.

All prices include paint, seam filler, copper-clad steel wire, waterproof cement for proper application, and fitting filler where necessary.

Discounts applying to sectional pipe covering and molded form pieces are quoted f.o.b. the buyer's location for any state. Such discounts range as follows: For list price purchases up to $500 the discount is 42 to 50.5 percent off list. For list price pur-

Table I—Guide for Thickness and Size of Cork Insulation

Temperature, Deg. F.	Pipe, 1/4-1 1/2	Pipe, 2-7	Pipe, 8-20	Pipe and Equipment, 20-54	Pipe and Equipment, 54-120	Equipment and Flat Surfaces Over 120 In.
	Pipe or Equipment Diameter, Inches					
	Insulation Type and Thickness, Inches					
−300 to 250	6-8, C	9-11, C	12-14, C	14-16, L	16-18, B	22, B
−250 to 200	5-7, C	8-10, C	11-13, C	13-15, L	15-17, B	18, B
−200 to 150	5-6, C	7- 8, C	9-11, C	11-12, L	12-15, B	15, B
−150 to 100	4-5, C	6- 7, C	8- 9, C	9-10, L	10-12, B	12, B
−100 to 50	4, C	5- 6, C	7- 8, C	8- 9, L	8-10, B	10, B
−50 to 20	4, C	4- 5, C	5- 6, C	6- 7, L	7- 9, B	9, B
−20 to 0	*STB*, C	*STB*, C	5, C	5- 6, L	6- 8, B	8, B
0 to 20	*BT*, C	*STB*, C	*STB*, C	4, L	4- 6, B	6, B
20 to 50	*BT*, C	*BT*, C	*BT*, C	3, L	3- 4, B	4, B
50 to 100	*IWT*, C	*IWT*, C	*IWT*, C	2, L	2, B	2, B

Key: C, Sectional pipe covering; L, Lagging; B, Board; *STB*, Special Thick Brine sectional pipe covering, 2.63 to 4 in. thick; *BT*, Brine Thickness sectional pipe covering, 1.70 to 3 in. thick; *IWT*, Ice Water Thickness sectional pipe covering, 1.20 to 1.93 in. thick.

Table II—List Prices of Sectional Cork Pipe Covering

(Basis, dollars per lineal foot)

Pipe Size, Inches*	Thickness (See Key, Table I) *BT*	*STB*	*IWT*
1/4	$1.25	$2.10	$1.00
3/8	1.25	2.10	1.00
1/2	1.25	2.10	1.00
3/4	1.35	2.10	1.05
1	1.55	2.60	1.20
1 1/4	2.00	2.60	1.25
1 1/2	2.25	2.90	1.40
2	2.35	3.50	1.55
2 1/2	2.70	3.50	1.55
3	3.30	3.95	1.85
3 1/2	3.65	5.30	2.25
4	3.95	5.30	2.55
5	4.80	6.35	2.95
6	5.30	7.80	4.20
8	6.80	13.00	5.50
10	11.45	14.85	8.65
12	12.35	16.10	8.45
14	14.00	17.90	9.05
16	14.85	18.95	10.30
18	15.95	21.30	11.30
20	17.15	23.05	11.90

* *Note:* Coverings for 4 1/2, 7, and 9 in. take the price of 5, 8 and 10 in.

Table III—List Prices for Brine Thickness Molded Cork Covers

(Basis, dollars per fitting)

Pipe Size, Inches	90-Deg. Screwed Ells, Std., 125 Lb.	90-Deg. Screwed Ells, Std., 250 Lb.	90-Deg. Screwed Ells, Long Turn, 125 Lb.	45-Deg. Screwed Ells, 125 Lb.	45-Deg. Screwed Ells, 250 Lb.	Screwed Tees, 125 Lb.	Screwed Tees, 250 Lb.
1/4	$1.40	$1.55	$2.15	$1.40	$1.55	$1.55	$1.70
3/8	1.40	1.55	2.15	1.40	1.55	1.55	1.70
1/2	1.40	1.55	2.15	1.55	1.95	1.85	2.15
1	1.70	2.25	2.15	1.70	2.25	1.90	2.75
1 1/4	2.40	2.70	3.00	2.40	2.70	2.65	3.20
1 1/2	2.70	3.85	3.45	2.70	3.85	3.30	4.25
2	3.20	4.65	4.30	3.20	4.65	3.85	5.40
2 1/2	4.00	5.60	4.70	4.00	5.60	4.80	6.30
3	5.85	6.65	7.10	5.55	6.35	7.10	7.90
3 1/2	7.15	7.95	8.35	6.80	7.55	8.05	9.80
4	7.80	9.45	9.20	7.40	9.00	9.80	12.30
5	9.95	12.80	14.75	9.45	12.15	12.15	16.25
6	13.35	13.70	16.50	12.70	13.05	16.20	19.05

Ammonia Fittings: The prices listed for 250-lb. fittings apply also to ammonia fittings. In addition, short coupled ells for ammonia piping are available in sizes from 1/4 to 1 1/4 in. at list prices ranging from $2.35 to $4.70.

STB Thickness: Manufacturers have no formula for determining the list prices on a percentage basis. For estimating purposes, it is close enough to add 100 percent to the list prices for *BT*.

IWT: For estimating purposes it is close enough to deduct 50 percent from the list prices of *BT*.

Table IV—List Prices for Brine Thickness Molded Cork Covers

(Basis, dollars per fitting)

Pipe Size, Inches	Flanged Fittings: 90-Deg. Ells, 125 and 250 Lb., and Ammonia	90-Deg. Long Radius Ells, 125 and 250 Lb.	45-Deg. Ells, 125 and 250 Lb., and Ammonia	Tees, 125 and 250 Lb., and Ammonia
1/4	$4.90	$4.90	$4.90	$5.60
3/8	4.90	4.90	4.90	5.60
1/2	4.90	4.90	4.90	5.60
3/4	5.55	5.55	5.55	6.90
1	6.30	6.95	6.30	8.10
1 1/4	7.75	8.55	7.75	9.35
1 1/2	10.25	11.30	10.25	12.80
2	10.90	12.00	10.90	14.00
2 1/2	14.20	15.65	14.20	18.15
3	16.40	21.15	15.60	21.15
3 1/2	18.40	31.80	17.50	27.30
4	21.40	31.80	20.35	27.30
5	22.10	33.75	20.90	31.80
6	29.80	37.50	28.30	37.70

STB Thickness: For estimating purposes it is close enough to add 30 percent to the list prices for *BT*.
IWT: For estimating purposes it is close enough to deduct 30 percent from the list prices for *BT*.

Table V—List Prices for Brine Thickness Molded Cork Covers

(Basis, dollars per fitting or valve)

Pipe Size, Inches	125-Lb. Screwed Fittings and Valves: Crosses	Unions	Flanges	Globe and Angle Valves	Gate Valves
1/4	$2.05	$1.55	$1.90	$1.70	$1.60
3/8	2.05	1.55	1.90	1.70	1.60
1/2	2.05	1.55	1.90	1.70	1.60
3/4	2.45	1.95	2.55	2.10	1.95
1	2.55	2.25	3.10	2.40	2.15
1 1/4	3.50	2.70	3.75	3.10	2.80
1 1/2	4.40	3.85	4.95	3.55	3.70
2	5.10	4.65	5.05	5.30	5.90
2 1/2	6.40	5.60	5.60	7.50	8.00
3	9.45	6.65	7.35	9.45	9.75
3 1/2	10.75	7.95	8.20	13.35	13.50
4	13.10	9.45	8.20	13.35	13.50
5	16.15	—	11.00	16.45	16.75
6	21.60	—	12.85	20.55	20.60

Long sweep crosses: Add 43 percent to the price of normal 125-lb. crosses.
250-lb. crosses: Add 30 percent to the price of normal 125-lb. crosses.
Ammonia crosses: Add 25 percent to the price of normal 125-lb. crosses.
250-lb. flanges: Same as 125-lb. flanges.
Ammonia flanges: Same as 125-lb. flanges.
250-lb. globe and angle valves: Add 36 percent to the price of 125-lb. G. & A. valves.
Ammonia globe and angle valves: Add 40 percent to the price of 125-lb. G. & A. valves.
250-lb. gate valves: Add 40 percent to the price of 125-lb. gate valves.

STB Thickness: For estimating purposes it is close enough to add 75 percent to the list prices for *BT*.
IWT: For estimating purposes it is close enough to deduct 40 percent from the list prices for *BT*.

Table VI—List Prices for Molded Cork Covers of Brine and Special Thick Brine Thickness

(Basis, dollars per fitting or valve)

Pipe Size, Inches	125 and 250 Lb., and Ammonia: Flanged Crosses *BT*	Flanged Crosses *STB*	Flanges *BT*	Flanges *STB*	Globe and Angle Valves *BT*	Globe and Angle Valves *STB*
1/4	$7.45	$12.45	$1.90	$3.75	$6.60	$10.35
3/8	7.45	12.45	1.90	3.75	6.60	10.35
1/2	7.45	12.45	1.90	3.75	6.60	10.35
3/4	9.20	12.45	2.55	3.75	7.90	10.35
1	10.80	18.85	3.10	5.00	9.10	15.20
1 1/4	12.45	24.65	3.75	5.40	10.35	19.50
1 1/2	17.05	24.65	4.95	5.40	13.80	19.50
2	18.65	28.15	5.05	7.20	15.00	22.10
2 1/2	24.20	28.15	5.60	7.20	19.15	22.10
3	28.20	37.80	7.35	7.95	22.15	29.35
3 1/2	36.40	43.40	8.20	9.75	28.30	33.55
4	36.40	43.40	8.20	11.55	28.30	33.55
5	42.40	—	11.00	—	32.80	—
6	50.25	—	12.85	—	38.70	—

IWT: For estimating purposes it is close enough to deduct 40 percent from the list prices for *BT*.

chases of $500 to $7,500 the discount is 44 to 52.5 percent off list. For list price purchases of $7,500 and above the discount is 50.5 to 54 percent off list. The highest discount applies to the Atlantic Coast states and the lowest to the Western states. Intermediate discounts apply to states lying between these two extremes. These discounts are applicable to larger industrial buyers; the average small consumer will be allowed a discount of 4 percent less than quoted for the three brackets.

Table II gives list prices for sectional cork pipe covering in sizes from ¼ to 20 in. while Tables III to VI give list prices for screwed and flanged fittings and valves in sizes from ¼ to 6 in.

Fitting Covers

Refrigeration cannot be efficient without insulation of the fittings, valves, flanges, etc., in addition to the straight piping. Fitting covers are made from cork granules compressed and baked in molds; they are of exact size and fit snugly, thus permitting no space between cold surface and insulation where frost could accumulate.

Fitting covers are made in the same thicknesses as the corresponding straight pipe covering and are designed for all standard types of ells, tees, valves, crosses, flanges, unions, reducers and any other possible form of fitting. They are carefully sized to join the sections of the pipe covering without a break.

Covers for large size fittings may be furnished as separate lagging and assembled on the job, or ordered assembled at the factory and shipped in sections, ready to be applied.

Prices for fittings above 6 in. (laggings available in sizes 8 to 20 in.) are not listed in the various tables. Where such large pipes and fittings are involved, it is best to ask for quotations from one of the manufacturers. It is needless to mention that prices for fittings above 6 in. are much more expensive than 6 in. fittings. The prices run five to ten times higher (based on list prices) for the items of Table III, two to six times higher for those of Table IV and three to six times higher for Table V.

In all cases reducing fittings and blanked fittings take the price of the largest outlet while 4½-in. fittings take the price of 5-in. fittings.

Many attempts have been made to insulate valves, flanges, crosses and other large surface fittings on refrigerated lines by means of built-up methods. While it is true that the cost of the raw materials involved makes it appear as if savings would be possible in providing built-up covers for large-surface fittings, nevertheless the high cost of labor absorbs any benefits derived from lower material prices. In addition, if such built-up fittings are not exceedingly well filled with fitting fillers and carefully sealed, frost will enter the hollow spaces and after a certain time will push the insulation out of place, making efficiency illusory. In spite of the high cost of factory-molded fitting covers, still, in actual operation over a number of years, they prove to be the less expensive method of insulating cold lines.

Special Fitting Covers—Special fit-

ting covers for relief valves, tee valves, mixing valves, expansion valves, laterals or Y's, CO_2 valves and bypass valves, or any other off-size fittings, are available on special order. Prices cannot be listed here. Instead the estimator must furnish all dimensions to the manufacturer for price calculations. When ordering covers for valves it is necessary to specify whether the bonnet is screwed or bolted and the name of the valve manufacturer must be given in order to receive an exact fitting cover.

Corkboard and Lagging

For the insulation of equipment in general refrigeration, for cold storage work, and for roof insulation, a grade of insulation cork known as Standard Corkboard is used. The standard sizes for this grade are 12 × 36 in., 18 × 36 in., 24 × 36 in. and 36 × 36 in. Corkboard is sold on a square foot basis and the prices vary according to the location of the buyer. Table VII will enable the estimator to arrive at a fairly accurate figure per square foot for this particular location.

For piping and equipment having diameters of 20 in. up to but not exceeding 54 in., corkboard is furnished in form of lagging. Such laggings are coated on one or two sides, as requested. Prices per square foot for such lagging are listed in Table VIII. Disks of the same thickness are available at about 50 percent above the prices listed in Table VIII.

Installation Cost

Tables IX, X and XI give the cost of installation (not including the cost of the covering itself) prevailing in Spring 1947. They are based on labor at $2 per hour. In all cases the cost of sundry accessories necessary for an efficient job is included. Where labor cost is lower or higher, adjustment should be made on a percent basis. As an example of the use of these data refer to Table IX.

Example—If a 1-ft. length of molded pipe covering, or a piece of fitting covering, carries a list price of $2, then the cost of installation including accessories and the cork insulation itself is $2 plus 25 percent or $2.50 for Ice Water Thickness in installations less than 15 ft. above the floor.

While a percentage of the covering cost is used for pipe and fittings in Table IX, in the case of lagging and corkboard application (Tables X and XI) the installation cost basis is the average dollars for labor (at $2 per hr.), plus the necessary sundries for each thickness, and for various working conditions. As in Table IX the cost of the cork material is not included in the figures given in Tables X and XI and must be added in from Tables VII or VIII.

Cold insulation is more expensive than heat insulation. Although, as an example, a Houdry cracking unit recently required only 9.1 percent of total project cost for insulation, a modern large scale refrigeration job, installed a short time ago, required 21.4 percent of the total project cost. With the unstable market for equipment under present economic conditions, it is not possible to give the estimator a formula for the quick estimating of refrigeration insulation.

On larger jobs it is imperative to ask for bids from at least three suppliers. Although it will be found that the prices for the insulation materials are more or less uniform, on the other hand it is revealing to notice the large variation in applied insulation bids.

Repair Sundries

No figures can be given here for repair materials because the great number of packages of all sizes and the freight differentials to various points of destination would require an inordinate amount of space for presentation. Most manufacturers of cork insulation publish price lists for such materials including cork granules, asphalt, emulsified asphalt, emulsified asbestos-asphalt, seam filler, asphalt paint, asphalt cement, insulating paper, wire nails, copper-clad steel wire, skewers, fitting filler brine putty, and other necessary accessories.

Table VII—Net Prices* F.O.B. Various Locations for Standard Corkboard

(Basis, dollars per square foot)

Thickness, Inches	N. Y. City	N. Y. State	Pa.	Ohio	Mich.	Ill.	Wis.	Tex. and La.
1	$0.166	$0.169	$0.169	$0.171	$0.173	$0.175	$0.18	$0.19
1 1/2	0.234	0.239	0.239	0.242	0.245	0.248	0.255	0.27
2	0.312	0.319	0.319	0.322	0.326	0.33	0.34	0.36
3	0.468	0.477	0.477	0.483	0.489	0.495	0.51	0.54
4	0.624	0.636	0.636	0.644	0.652	0.66	0.68	0.72
6	0.936	0.954	0.954	0.966	0.978	0.99	1.02	1.08

* No discount.

Table VIII—Net Prices* F.O.B. Various Locations for Standard Corkboard Lagging

(Basis, dollars per square foot)

Thickness, Inches	N. Y. City	N. Y. State	Pa.	Ohio	Mich.	Ill.	Wis.	Tex. and La.
1	$0.37	$0.38	$0.38	$0.38	$0.38	$0.38	$0.39	$0.39
1 1/2	0.46	0.47	0.47	0.47	0.47	0.48	0.48	0.50
2	0.55	0.56	0.56	0.56	0.56	0.57	0.58	0.60
3	0.72	0.73	0.73	0.73	0.74	0.75	0.76	0.79
4	0.91	0.92	0.92	0.93	0.94	0.95	0.97	1.01
5	1.09	1.11	1.11	1.12	1.13	1.14	1.16	1.21
6	1.27	1.29	1.29	1.30	1.31	1.32	1.35	1.41
7	1.46	1.48	1.48	1.49	1.51	1.52	1.56	1.63
8	1.63	1.65	1.65	1.67	1.69	1.70	1.74	1.82
10	2.00	2.02	2.02	2.05	2.07	2.09	2.14	2.24

* No discount.

Table IX—Cost of Installing Pipe and Fitting Coverings

(Basis, percent of list price per foot for piping; per piece for fittings)

		Height of Piping: Below 15 Ft., Percent	Height of Piping: Above 15 Ft., Percent
Inside Buildings			
Thickness	*IWT*	25	31
	BT	22	28
	STB	17	22
Outside Buildings			
Thickness	*IWT*	43	54
	BT	35	44
	STB	30	38

Table X—Cost of Installing Cork Lagging and Cork Disks

(Basis, dollars per square foot)

Thickness of Single Layer, Inches	Inside: Installation Height, Below 15 Ft.	Inside: Installation Height, Above 15 Ft.	Outside: Installation Height, Below 15 Ft.	Outside: Installation Height, Above 15 Ft.
1	$0.90	$1.13	$1.30	$1.64
1 1/2	0.90	1.13	1.30	1.64
2	0.90	1.13	1.30	1.64
3	0.90	1.13	1.30	1.64
4	1.05	1.31	1.45	1.82
5	1.10	1.38	1.50	1.88
6	1.20	1.50	1.60	2.00
7	1.25	1.57	1.65	2.07
8	1.30	1.64	1.70	2.13
10	1.40	1.75	1.80	2.25

Table XI—Cost of Installing Scored Corkboard

(Basis, dollars per square foot)

Thickness, Inches	Number of Layers	Installation Height, Inside or Outside: Below 15 Ft.	Installation Height, Inside or Outside: Above 15 Ft.
1 1/2	1	$0.70	$0.88
2	1	0.70	0.88
3	2	1.05	1.32
4	2	1.05	1.32
5	2	1.05	1.32
6	3	1.40	1.75
8	3	1.40	1.75

Centrifugal Separator Costs

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IN ESTIMATING centrifugal separation equipment the principal problem is to determine the size of equipment necessary to accomplish a given separating job in the time allotted. There may also be the problem of determining what sort of separating equipment should be used in cases where previous experience with the mixture to be separated is not available. Except for preliminary estimates, therefore, manufacturers will have to be consulted and they will often have to make actual tests on the mixture to find the answer to one or both questions.

In most cases of preliminary estimates, however, it is possible to reason from previous experience, or by analogy, and determine both the equipment type and an approximation of the cost. To this end several manufacturers of typical centrifugal separation equipment were asked to give representative throughput capacities from which analogies might be drawn, together with corresponding equipment sizes, costs and other pertinent information.

Basket Centrifugals

Data on vertical-shaft basket centrifugals of both the suspended, bottom-discharge type and the underdriven type were supplied by the American Tool & Machine Co.

Suspended, Bottom-Discharge — Capacity-cost data are summarized in Table I. Many intermediate sizes are available, the sizes listed having been chosen because they closely approximate multiples of capacity. The table lists basic prices in steel for various basket diameters and also percentages of the basic price to be added to the latter for special features. These are added to the basic price and not cumulatively. Plows should not be used with rubber-covered baskets unless a positive non-accelerating speed of about 60 r.p.m. is provided for unloading in addition to the standard high speed for loading and spinning. Even without rubber covering, safety, screen protection and ease of operation make such a positive unloading speed desirable if not mandatory.

Underdriven Type — Capacity-cost data for this type are summarized in Table II. The base-bearing type is made in basket diameters to 30 in. but is not ordinarily recommended for diameters over 26 in. if handling slow-draining loads. Link-suspended machines are built in sizes below 30 in. but their greater cost is seldom justified below that size. Underdriven centrifugals have shallower baskets than the suspended type to permit hand unloading and so have somewhat smaller capacity for a given diameter in the larger sizes than the suspended type. Where suspended centrifugals are used for the rapid handling of average and heavy chemicals, the underdriven type is used largely for fine chemicals, pharmaceuticals, where a variety of products must be handled in the same machine, or where a filter bag is required.

Selection—Volume capacity of a basket centrifugal is only one factor in determining time capacity. To estimate the size required it is also necessary to know the operating cycle that can be maintained. Table III lists a few typical cycle times and weight capacities for 40-in. machines in a variety of industries. In general, bottom-discharge machines with mechanical unloaders have shorter cycles than underdriven machines. Free-draining crystals in a slurry of 50 percent or more crystal concentration (e.g. sugar massecuite) can be handled at very high production rates, with 2 to 5 min. cycles for charging, washing, spinning and unloading. Special large valves and feeder lines must be used for such short cycles. With sugar there is no problem in washing the crystals free of salt, chlorides, etc., as may be encountered with chemicals.

In general chemical service it is well

Table I—Suspended Bottom-Discharge Centrifugals

(F.o.b. Hyde Park, Boston, Mass.)

Approx. Basket Capacity, Cu. Ft.	Basket Diam., Inches	Horse-power	Weight, Lb.	Basic Price, Steel, Dollars*	—Percentages Added for Special Features— (See Note Below) Feature A	B	C	D	E
1	20	2	1,400	1,200	10†	50	30	11	14
2	26	3	4,000	2,300	16	40	23	11	14
3	30	5	4,400	2,500	15	40	23	11	14
6	36	10	7,000	2,900	15	50	25	11	14
9	40	15	8,000	4,000	15	50	25	11	14
11	48	25	10,000	4,600	12	50	25	12½	15

* Single-speed, two-speed or two-torque open motors; no unloaders.
† Plow only on pilot plant size. Larger sizes have plow and three-speed drive.
Special Feature Note: (*A*) Mechanical unloader, three-speed drive; (*B*) Stainless Steel; (*C*) Rubber covered; (*D*) Totally inclosed, fan-cooled motor; (*E*) Explosion-proof motor.
Freight Note: See note, Table II.

Table II—Underdriven Basket Centrifugals

(F.o.b. Hyde Park, Boston, Mass.)

Approx. Basket Capacity, Cu. Ft.	Basket Diam., Inches	Horse-power	Weight, Lb.	Basic Price, Steel, Dollars	—Percentages Added for Special Features— (See Note with Table I) Feature B	C	D	E
1*	20	2	1,000	1,200	40	18	9	11
2*	26	3	2,500	1,600	45	18	9	11
3†	30	5	3,500	2,000	50	18	9	11
7½†	40	7½	4,000	2,400	70	32	9	11
10½†	48	10	4,500	2,700	18	32	7	11

* Base-bearing type. † Link-suspended type.
Freight Note: Centrifugals take LCL second class (Official) rate. Rate per cwt. per 100 mi. is (1) LCL, local, 40c.; 1,000-3,000 mi., 20c.; (2) Carload, local, 20c.; 1,000 mi., 8.5c.; 2,000 mi., 11c.; 3,000 mi., 13c.

Table III—Typical Basket Centrifugal Capacities

(Basis: 40-in. diam. machine)

Product	Cycle Time, Min.	Load, Lb.
Sugar	2–5	350–500
Metal turnings	6	1,200
Tex. piece goods	15	70–120
Waste	10	80
Stockings	15	120
Inorg. salts	10–15	350–700
Fine powders	30	350

to assume tentatively four to six loads per hour for fairly free-draining crystals in concentrations of 25 percent or more of solids. For fine powders or slurries containing less than 10 percent solids, two charges per hour may be assumed. With fines, slimes or compressible products, or flat crystals, cycles of 45 min. or longer may be expected, especially if washing is needed (chloride removal particularly), or the solid-liquid ratio is low. Where the solids are so fine that they might be lost through fine screens or through strips of filter cloth held in place by expander rings, then it is desirable to use an underdriven machine with a filter bag, which can easily be inserted in such a machine and removed for washing. With an underdriven machine the slower hand unloading is required but this may be of little consequence where high priced products are handled or fines loss must be avoided. Use of filter bags is convenient when a variety of products must be handled in the same machine. Two or four loads per hour (with two a safe average estimate) should be figured for underdriven centrifugals, depending on crystal size, slurry consistency and washing conditions. With either type of centrifugal it is necessary to increase the cycle times shown in Table III where slimy or very fine grained products are handled.

Horizontal-Shaft Machines

Data on horizontal-shaft ter Meer centrifugals of both the automatic and continuous types were supplied by Baker Perkins, Inc.

Automatic Type—This machine is of high-tonnage batch type with automatic cycle control of charging, spinning, washing and discharging. In general it can be used for either centrifugal filtration or clarification on any product that can be handled on a uniform cycle in manually operated batch units. Table IV lists sizes, nominal capacities and costs. Capacity varies, of course, with the material handled, the capacity given being based on a cake discharged with 13.5 percent moisture, feeding a slurry of 20 percent solids having a particle size of 60 percent on 200 mesh and 89 percent on 400 mesh.

Table IV—ter Meer Automatic Cycle-Controlled Centrifugals

(F.o.b. Saginaw, Mich.)

Size	Basket Capacity, Cu. Ft.	Connected Hp.		Avg. Power Consumed, Hp.	Nominal Capacity, Lb./Hr.*	Ship. Weight, Lb.	Net Cost (Std., Iron), Dollars†
		Drive	Control				
HS-18	0.5	3	2	3	600	2,200	3,106
HS-24	1.25	10	2	7	1,200	5,500	6,850
HS-36	4.15	15	3	10	3,600	11,000	10,250
HS-54	12.3	30	3	23	9,000	15,000	19,437
HS-66	20.5	40	3	40	18,000	18,000	21,219
HS-81	36.1	60	3	48	22,000	29,000	24,450

* See text regarding capacity data; capacity depends on material.
† Housing, cast iron or steel; basket, steel or stainless; add 10–80 percent for stainless.

Table V—ter Meer Continuous Centrifugals

(F.o.b. Saginaw, Mich.)

Size	Connected Hp.		Avg. Power Consumed, Hp.	Nominal Capacity, Lb./Hr.*	Ship. Weight, Lb.	Net Cost (Std., Iron) Dollars†
	Drive	Pump				
S-12	2	3	1.8	550	3,000	5,450
S-24	7.5	7.5	10	4,500	6,500	7,050
S-30	10	10	15	9,000	9,000	10,000
S-36	15	20	25	15,000	11,000	12,350
S-42	15	30	30	24,000	13,000	14,275
S-48	20	40	40	35,400	19,500	17,125

* Varies widely with material; based on ammonium sulphate; see text.
† Steel, stainless, bronze, etc., available as needed. Base price all iron and steel; add 15–80 percent for other materials.

Continuous Type—This machine is used for separating free-draining solids from slurries of high solids concentration (in general, 40 percent or more solids of crystalline, granular or fibrous character, with at least 90 percent retained on 100 mesh). Continuous feed and intermittent discharge are employed, the latter being secured by a reciprocating pusher which pushes annular rings of dehydrated material from the spinning drum into a dry housing at regulated intervals. Efficient washing with wash liquor separation from the mother liquor can be secured. Table V gives sizes, nominal capacities and costs. Capacity varies widely with the material handled, being based in the table on ammonium sulphate produced at 2 percent or less final moisture, with a crystal size of 75 percent on 40 mesh.

Conveyor-Discharge Centrifugals

Data on continuous centrifugals of the rotating-conveyor-discharge type were supplied by Bird Machine Co.

Solid-Bowl Type—Such machines, used for both continuous separation and continuous classification, are widely used for many different products. Installation costs average 10 to 25 percent of purchase price, including foundations. Sizes, relative capacities, costs and other data are given in Table VI. It should be noted that capacities depend on the material handled and may be limited either by the volume of solids that can be raked, or by the maximum volume of feed liquid that can be clarified in a given time. The table gives three different capacity criteria including cubic feet of solids per hour, maximum feed rate and relative volumetric clarifying capacity. Assuming an ordinary crystalline material, a discharge capacity of 30 cu.ft. per hour corresponds to about 1 ton of solids per hour for the 18 x 28 in. machine, with other sizes in proportion to the indicated output volumes. The maximum feed rate shown in the next column is the gallons per minute feed rate which if exceeded may allow a part of the solids to carry over with the filtrate. The relative clarifying capacity depends on the settling characteristics of the material handled. For example, if 10 g.p.m. can be clarified in the 18 x 28 in. machine, then a 36 x 72 in. machine can clarify 100 to 120 g.p.m. In a typical application a 20 percent solids suspension of NaCl crystals (mostly plus 200 mesh) is separated from a 25 percent electrolytic NaOH solution, discharging solids-free caustic and solid salt of 4-5 percent moisture and less than 0.3 percent NaOH, using 0.3 lb. wash water per pound of crystals.

Screen Type—Bird makes a 24 x 24 in. screen type continuous centrifugal

Table VI—Bird Solid-Bowl Continuous Centrifugals

(F.o.b. East Walpole, Mass.)

Size, Inches	Horsepower	Weight, Lb.	Capacity Criteria*			Approx. Price, Dollars	
			Solids, Cu. Ft. Per Hr.	Max. Feed, G. P. M.	Rel. Vol. Clarifying Capacity	Steel	304 Stainless
18 x 28	10	2,775	30	25	1	6,000	7,500
24 x 38	25	5,310	60–90	70	2–25	8,000	11,000
32 x 50	50	.....	180–200	150	5–6	11,000	10,000
36 x 50	40	13,000	180–200	150	5–6	11,000	16,000
36 x 72	75	17,240	180–200	150	10–12	16,000	21,000
40 x 60	75	15,420	300	250	10	16,000	21,000
54 x 70	150	32,000	400–1,200	500	20	27,000	40,000

* See text for explanation.

which has about 4 tons per hour capacity on crystals, uses a 20 hp. motor and sells in stainless steel for about $15,000.

High-Speed Centrifugals

Centrifugals of this type include tubular-bowl and disk-bowl machines, used both for liquid-liquid and liquid-solid separations. Capacities are particularly difficult to anticipate for applications of the types carried out in such machines and hence cost estimating without definite information from tests is unreliable. Apparently small changes in operating conditions may make large differences in capacity. For example, a substantial increase in capacity occurs in certain liquid-liquid extraction operations in penicillin manufacture when a very small amount of wetting agent is added to help break emulsions.

To give a general idea of the range of costs with such equipment, Sharples Corp. states that for a simple job such as transformer oil, a Super-Centrifuge to handle 1,200 g.p.h. would cost about $2,800, or $2.30 per gallon per hour, and that this cost would be increased by accessory equipment (pumps, blotter presses, heaters, etc.) to a maximum of about $4.80 per gallon per hour, depending on the quantity of accessory equipment used. Operating cost would be about $0.02 per gallon. For a job of intermediate difficulty, such as the separation of 350 g.p.h. of penicillin broth from 150 g.p.h. of amyl acetate the cost of a Sharples D-2 centrifuge would be about $7,200, or $20.50 per gallon of broth handled per hour. Operating costs would range from $0.02 to $0.03 per gallon per hour. For an extremely difficult job for 800 g.p.h. of dry tar, a complete Sharples separation process including centrifuges, strainers and other auxiliaries would cost about $30,000, or $40 per gallon per hour of tar. Operating cost would be about $0.10 per gallon.

Comparable costs for high-speed machines are mentioned by the DeLaval Separator Co. for machines carrying out simple jobs such as the purification of lubricating and insulating oils. For a job of intermediate difficulty, for example, the de-gumming of vegetable oils, a high-speed centrifugal having a capacity of 450 g.p.h. (or better) would cost in the neighborhood of $6,000. What is described as one of the most difficult of purification operations currently being carried out in high-speed disk-bowl machines is the clarification of rubber latex. The approximate cost for a large machine capable of performing this purification at about 100 g.p.h. is $5,000.

Grateful acknowledgement is made to the following individuals for supplying the information presented above, including W. C. Crandall of American Tool & Machine Co., J. R. Powers of Baker Perkins, Inc., F. X. Ferney of Bird Machine Co., and J. T. Costigan of Sharples Corp.

Ejectors and Condensers

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Cost of steam jet ejectors depends mainly on capacity, vacuum, type of equipment, and general economic conditions but consideration must also be given to special materials of construction, and corrections must be made for special conditions of steam pressure, discharge pressure and for extras.

Price is determined by use of the formula

$$P = epvt + x$$

where P = selling price, e = economic cycle factor, p = base price factor depending on capacity, v = vacuum factor, t = type factor and x = corrections for special conditions. The base price factor varies with capacity which may be defined as the total weight of fluid entering the suction of a single ejector element in lb. per hr. This is given on the price curve on Fig. 1. Factor e corrects for changes in general economic conditions. Based on the year 1940 when e was taken as 1.000, its present value has risen to 1.275.

A curve for the vacuum factor v, is also shown on Fig. 1. This is a function of the absolute pressure in inches of Hg at the suction of the injector. Note the deflections of the curve in the region from 3 to 6 in. Hg. This is an indeterminate area where either 1 or 2 stage ejectors may be used depending on individual conditions of service. Where suction pressure is given in mm. of Hg, assume for

Table I—Type Factors for Ejectors

Type of Equipment	Factor,
Single stage ejector designed for a discharge pressure of 14.7 lb. per sq. in. or higher	0.80
Two stage, non-condensing type	1.4
Two stage with barometric type intercondenser only	1.7
Two first stages and two second stages with one common barometric type intercondenser only	3.2
Two first stages and two second stages with one common barometric type intercondenser and one common barometric type aftercondenser	3.8
Two stage with surface type intercondenser only	2.4
Two stage with surface type inter-and after-condensers	3.0
A single element ejector or booster designed to compress over a very limited pressure range and discharging against a back pressure materially less than 14.7 lb. per sq. in. abs.	0.68
Two boosters connected in series, without inter- or after-condensers and having a pressure at the discharge of the final stage materially less than 14.7 lb. per sq. in. absolute	1.1

This chart gives two of the four principal factors that enter into the pricing of steam ejectors: base price factor p, which depends on ejector capacity, is multiplied by vacuum factor v, based on the absolute suction pressure against which the ejector must work; this must then be corrected for an economic cycle factor, based on current economic conditions, for a type factor from Table I, and for special suction or discharge conditions, special materials of construction, and for the cost of any special accessories that may be required

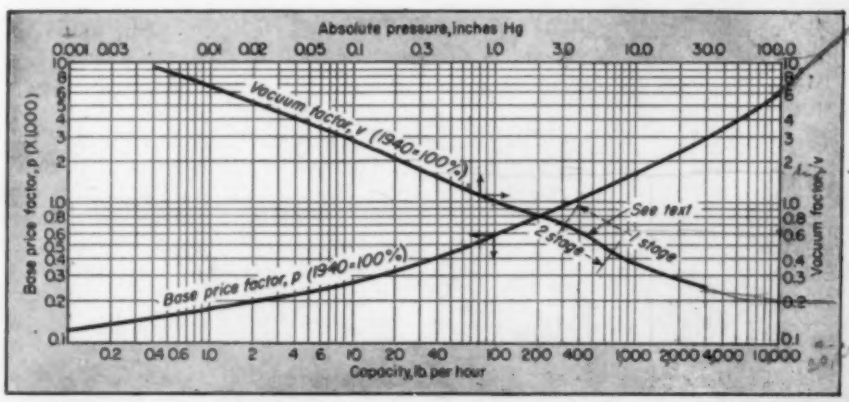

Absolute pressure, inches Hg
0.001 0.003
0.01 0.02 0.05 0.1 0.3 1.0 3.0 10.0 30.0 100.0
Vacuum factor, v (1940=100%)
See text
2 stage
1 stage
Base price factor, p (1940=100%)
Base price factor, p (X 1000)
Vacuum factor, v
0.2 0.4 0.6 1.0 2 4 6 10 20 40 100 200 400 1000 2000 4000 10,000
Capacity, lb per hour

Table II—Price Corrections for Special Materials of Construction

Type of Equipment	Percentage Corrections Added to Calculated Price[1] Special Material Classification[2] 1	2	3	4
Boosters	155	105	40	75
Booster condensers and barometric	280	30	60	100
after condensers surface	360	130	80	100
1 and 2 stage non-condensing ejectors	95	45	25	40
2 stage condensing ejectors	145	70	40	60

[1] Individual parts of the equipment can be made of special materials and the price increase will be a corresponding fraction of the corrections listed.

[2] Class 1 — Monel, stainless steel, high silicon irons, carbon. Class 2 — Bronzes, Everdur; for lead lined steel add 8 percent to the correction listed in the table for class 2. Class 3 — Ni-Resist and similar alloys, cast steel. Class 4 — Lead, antimony lead, phenolic plastics.

price purposes that 1 mm. = 0.04 in.

Type factors *t*, given in Table I vary with the number of stages both in series or in parallel and the type of unit employed. Although not shown in the tables, minimum prices exist for each type of equipment. These, however, are not generally encountered except when small size or pilot plant equipment is specified.

Only 1 and 2 stage ejectors are covered in Table I so it is necessary to price 3 stage ejectors in a different manner. Since a 3 stage ejector is a combination of a 2 stage ejector and a booster ejector hooked up in series it is priced by figuring a 2 stage system as shown above and adding to it the cost of a separately figured booster ejector and booster condenser. However, when sold as part of a 3 stage unit, the 2 stage portion is figured for the dry non-condensible gas alone and the vacuum factor is omitted from the formula calculations.

To figure the cost of the booster and its condenser, calculate the booster as a single stage ejector from data given in Fig. 1, Table I, and Table II (if necessary) and add to this the cost of a booster condenser. If the condenser is barometric its cost is: base price of booster (Fig. 1) × vacuum factor of booster (Fig. 1) × 0.31. If the barometric condenser has a tail pipe add 25 percent to the price. Cost of surface type condensers is: Base price of booster × vacuum factor. Minimum prices are set on this equipment and apply when small sizes are used.

Special materials of construction which affect equipment prices are given in Table II. Other factors that must be considered are as follows:

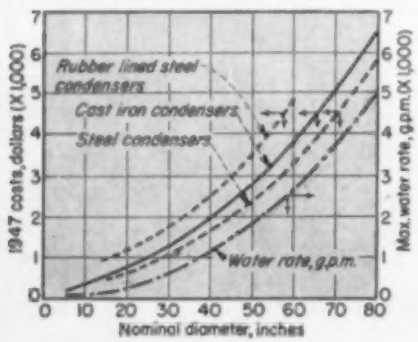
Steam pressure: For boosters the price is based on a steam supply with a minimum gage pressure of 70 lb. per sq. in. Where pressures lower than this are used the price is increased 0.5 percent for each pound of pressure below 70.

Discharge pressure: (a) For single stage or 2 stage noncondensing types the price is based on 1 lb. per sq. in. gage discharge. For higher discharge pressures the price is increased 4 percent for each pound of pressure above 1 lb. per sq. in. gage. (b) The price of 2 stage ejectors is based on 1 lb. per sq. in. gage discharge pressure. Where higher discharge pressures are used the price is increased 1 percent for each pound of pressure above 1 lb. per sq. in. gage.

Extras: Essential valves and bourdon gages are included in the regular price. Tail pipes, air meters, special gages, bourdon thermometers, reducing valves and other special equipment are extra.

Barometric condenser prices depend on water throughout. The curves in Fig. 2 show the cost of condensers made from various materials, together with a curve of maximum water rate for using in approximate size estimation.

Fig. 2—Approximate costs of steel, C.I. and rubber lined steel barometric condensers in 1947; for judging size a curve for maximum water rate is given


Rubber lined steel condensers
Cast iron condensers
Steel condensers
Water rate, g.p.m.
1947 costs, dollars (X 1,000)
Max. water rate, g.p.m. (X 1,000)
Nominal diameter, inches
0 10 20 30 40 50 60 70 80

Complete Ammonia Plants

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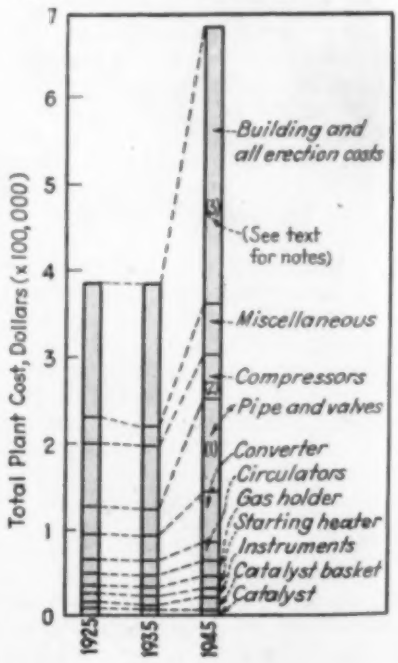
Costs of synthetic ammonia plants of 9,000 tons per year (100 percent NH_3) capacity are summarized in the accompanying cumulative bar chart. The data cover costs of compression and synthesis equipment only, since a variety of sources for synthesis gas is available. The prices plotted were those actually paid for equipment in the years indicated and cover one catalyst charge, one catalyst basket, necessary instruments, one gas fired starting heater, one 50,000 cu.ft. water sealed gas holder, two circulators, one 350-atm. converter, necessary high pressure piping and valves, two 350-atm. compressors, miscellaneous equipment, building, and all erection charges. General contractor's fee is not included. Cost per annual ton ranges from $43.04 in 1925, through $42.80 in 1935 to $76.25 in 1945 and early 1946. Despite the over-all cost increase the percentage for equipment is fairly constant, at 59.5, 57.0 and 52.8 percent in the three years.

The plants are not entirely comparable, some technological changes having taken place. Principally these are indicated by the figures on the 1945 bar, where (1) calls attention to the substitution of motor-operated for manual valves; (2) notes the substitution of high-speed 350-atm. compressors; and (3) indicates that the cost of engineering is higher than the bar would suggest, since it is in part offset by decrease in engineering fee.

Principal cost items in synthetic ammonia plants built in 1925, 1935, and 1945; note that the data do not include costs of equipment for the production of synthesis gas, several methods being available



Equipment Freight Cost

EDITORIAL STAFF

COST OF FREIGHT is a minor item in comparison to the purchase price of most chemical processing equipment. For example, a continuous centrifugal in stainless steel will cost about $1 per pound of weight, whereas the freight cost for shipping a unit weighing 10,000 lb. for 1,000 miles (l.c.l.) will be only about $175, which is less than 2 percent of the total cost of the unit.

Local Handling High

Local trucking cost will often be many times higher. Even where there is a siding at the place of destination, it may require the services of a rigger with special equipment to unload a heavy piece of machinery and place it on the foundation site. In the past the practice has been to include the freight cost as part of installation costs. Where shipping distances are great and when detailed installation costs are known, it may be expedient under most circumstances to estimate freight costs separately.

Also, although it does not amount to much, it is worth recalling that there is a federal tax of 3 percent on freight shipment costs.

Freight rates for the shipment of chemical processing equipment vary with the type as well as with the method of shipping, whether as loose parts, knocked-down, crated, or on skids. Furthermore, the rate varies with the region, the route, and the railroad.

Formulas for Estimating

For purposes of spot estimates the freight rate can be approximated quite closely from the second-class rates for machinery, in which class most equipment shipments will fall. In Eastern United States for a typical haul of 400 miles, the cost per ton-mile will be about 2½c. for carload shipment, and about 5¼c. for less-than-carload. Closer estimates can be obtained by use of the following formulas:

Eastern United States

Carload Rate (30,000 lb. min. carload):

$$CL = 25 + 0.06\ M$$

Less-than-Carload Rate:

$$LCL = 55 + 0.12\ M$$

where *CL* and *LCL* are the total freight charges in cents per 100 lb., and *M* is the air-line distance between the shipping points. For a circuitous route, however, a closer mileage estimate should be used.

In Western United States rates tend to be higher owing to mountain hauls and lighter traffic. The coast-to-coast rate varies per ton-mile from about 2¼c. for carload to 4¼c. for less-than-carload shipments. Closer estimates of transcontinental rates, for distances from 1,000 to 2,400 miles, can be obtained from the following formulas:

Transcontinental Rates

Carload Rate (30,000 lb. min. carload):

$$CL = -75 + 0.16\ M$$

Less-than-Carload Rate:

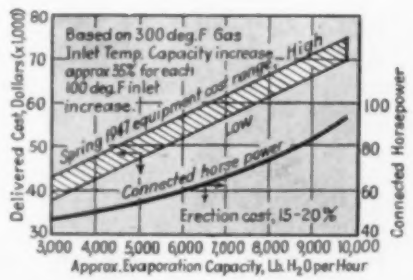
$$LCL = -80 + 0.26\ M$$

where *CL* and *LCL* are the total freight charges in cents per 100 lb., and *M* is the air-line distance (or a closer estimate) between the shipping points.

Estimating Spray Dryers

DATA provided by the Swenson Evaporator Co. may be used for the approximate price estimating of Gray-Jensen spray dryers. As usual with equipment which is custom engineered for each particular application too much weight must not be accorded to estimates of this character, since capacity, arrangement of equipment, auxiliary equipment, etc., necessarily vary with each problem. Consequently, for anything more accurate than preliminary estimates the specific problem should be put to the manufacturer.

Bearing these limitations in mind, it is possible to generalize on a range of costs for each capacity for any given inlet gas temperature, correlating hourly evaporation against equipment cost. The accompanying chart presents such a correlation for a 300 deg. F. inlet temperature, based on a dryer having all parts in contact with the product made of Type 304 stainless steel. The manufacturer's specifications include air filters (if needed), primary fan, finned tube radiators or direct-fired air heater, stainless steel drying chamber, wet or dry collector, stainless steel atomizing system including pump and drive, stainless steel product collecting system, instruments, insulation and miscellaneous parts from which a complete plant can be fabricated.



Approximate delivered equipment cost and connected horsepower for Gray-Jensen spray dryers

On the chart are noted average percentages for installation cost based on erection with the manufacturer's own skilled personnel, plus local labor on a cost plus basis. The indicated capacity is given as a guide only, since capacity is dependent on the characteristics of the material being dried. This capacity, based on a 300-deg. F. inlet gas temperature, with a wet collector used as a pre-evaporator, will increase approximately 35 percent for each 100 deg. F. increase in the temperature of the inlet gas.

The same chart shows approximate total horsepower requirements for each evaporation capacity. Drying chamber size is taken at 10 ft. diameter for 3,000 lb. per hour evaporation, 14 ft. for 6,500 lb. and 18 ft. for 9,600 lb. The overall space requirements for these three diameters are respectively 16 x 25 x 30 ft. high; 21 x 32 x 35 ft. high; and 24 x 40 x 44 ft. high.

Refrigeration Costs

FOR PRELIMINARY estimating purposes the cost of complete refrigeration systems can be roughly approximated by means of the accompanying chart. The cost of equipment to produce 1 ton of refrigerating effect is largely dependent upon the temperature at which the refrigeration takes place, increasing sharply as the evaporator temperature is reduced. Other conditions affecting the cost are method of condensing, and construction materials required. In the curve

(*Continued on page 138*)

Data for Equipment Cost Estimates

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A CHEMICAL ENGINEER is frequently confronted with the problem of estimating the manufacturing cost of a product, a significant portion of which is overhead cost of equipment. This figure, on an annual basis, is arrived at by the application of a reasonable percentage to the investment for equipment. In order to determine such investment accurately, it is necessary to carry out a refined design and to submit the resulting information to manufacturers for quotations. This is a time-consuming process, and in many instances such a period is not available. In such cases, it usually suffices to make only preliminary estimates of the sizes of various equipment items involved and to estimate the cost of such items rather than to depend on quotations. It is the purpose of this paper to present generalizations with which it is possible to estimate the cost of a considerable variety of equipment, provided only the most important factors influencing costs are known.

Previous attempts at such generalization[2, 3] have on the whole been satisfactory, and the figures given here represent essentially a modernizing and extension of those beginnings. The costs given in this chapter are correct as of Autumn 1945, with certain exceptions as noted later.

Since the middle of 1946 equipment costs have advanced sharply but by no means uniformly. Although prices have now shown signs of stabilizing in some equipment lines, this is still not true generally. Furthermore most prices still carry escalator clauses. Therefore, it is felt that the late 1945 costs on which most of the data in this paper are based probably give a truer picture of cost relationships than could be obtained at present. However, it is recognized that 1945 costs will not be of much value in actual estimates for the next few months at least, so the aid of the manufacturers has been sought in securing rough percentages for correcting data to a Spring 1947 basis. In a few cases where there appears to be no advantage in retaining the 1945 data, 1947 prices have been employed and indicated as such.

It must be realized at the outset that process equipment is usually specialized, and certain small changes may affect the cost to a considerable degree. These figures have been collected for equipment meeting the approximate specifications described in the text. While attempts have been made to provide factors by which costs for other specifications may be estimated, it should be noted that they are approximations only. For refined estimates, recourse must be had to manufacturers' quotations.

Taken from the chapter on process equipment costs prepared by Prof. Bliss for the forthcoming Third Edition of "Chemical Engineering Economics," edited by Chaplin Tyler and to be published by McGraw-Hill Book Co., Inc.

Pipe and Tubing

Variables which govern the cost of pipe and tubing are, in general, the construction material, diameter, thickness, length, and quantity ordered. The first three of these are of considerably greater importance than the last two and are used as the principal variables in the compilations to follow. The last

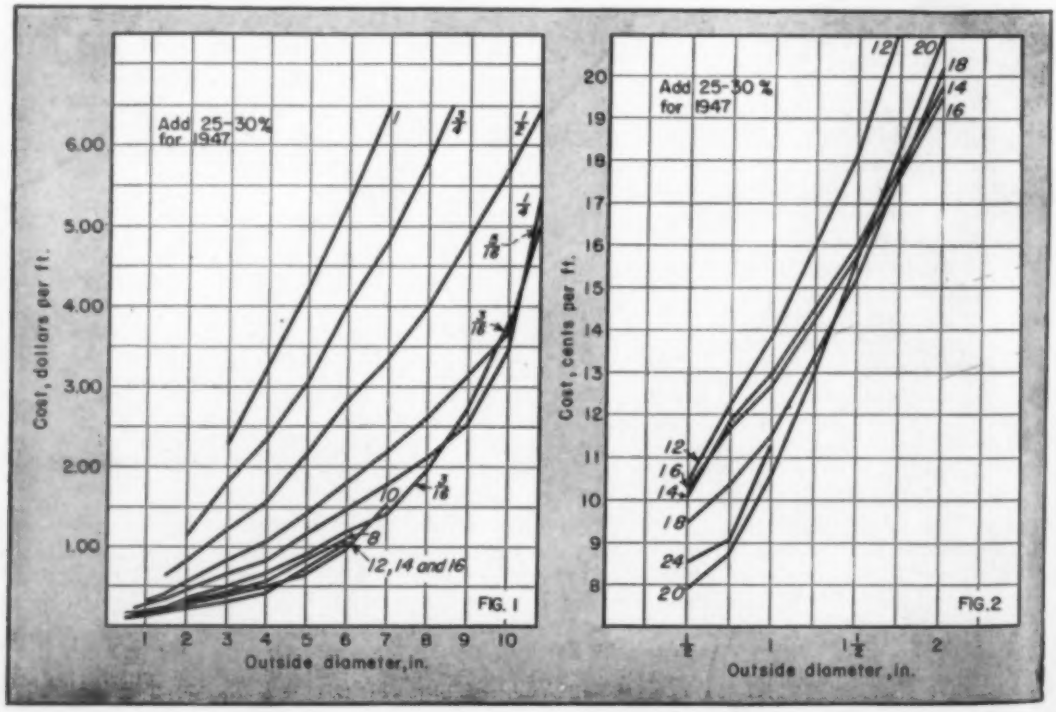


Fig. 1—Costs for seamless steel tubing, thickness in inches or B.W.G.

Fig. 2—Costs for seamless steel tubing, thickness in B.W.G.

two have been eliminated by assuming random lengths, and quantities large enough to expect no further discounts for this reason. These quantities vary widely among materials but are of the order of several hundred to several thousand pounds. If cutting to special lengths is required the costs should be increased by about 10 to 15 percent for stainless and seamless steels, 3 to 5 percent for nickel alloys, and practically not at all for copper alloys. The unit costs for various materials as functions of diameter and thickness are summarized herewith.

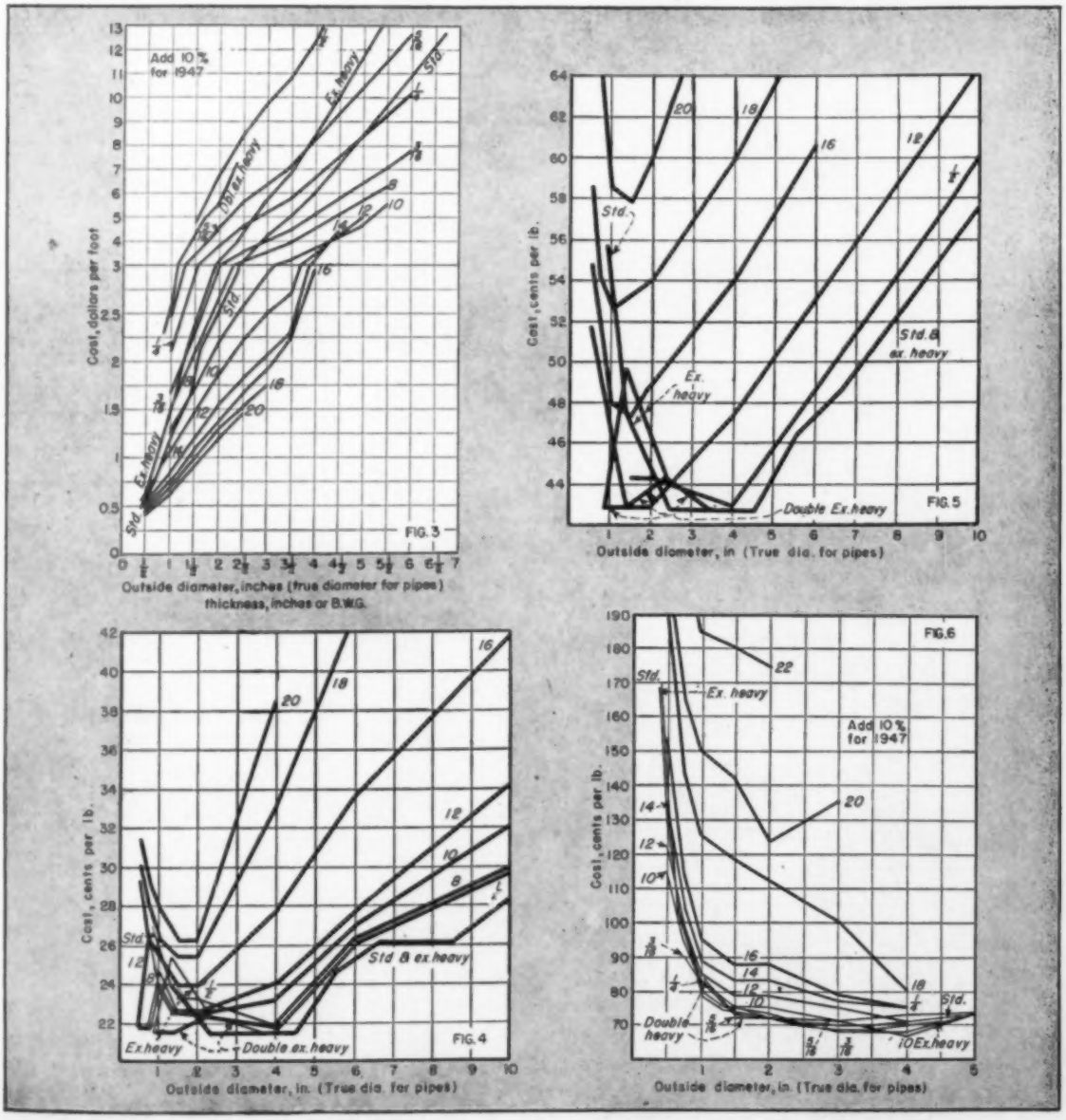
Steel—The cost of standard and extra strong steel pipes in sizes larger than 1 in. for 1947 is approximately 5 c. per lb. depending on size of pipe and geographical location. Discount rates vary for different locations so they must be considered where accurate estimation is required. The weights per foot of all these pipes are listed in the "Chemical Engineers' Handbook"[4]. Spiral-welded steel pipe costs approximately 8 c. per lb for 1947. The cost of seamless steel tubing, much more dependent on diameter and thickness, is illustrated in Fig. 1. This shows the cost in dollars per foot as a function of outside diameter for various wall thicknesses. No attempt has been made to draw these data as smooth curves, since they are essentially irregular functions.

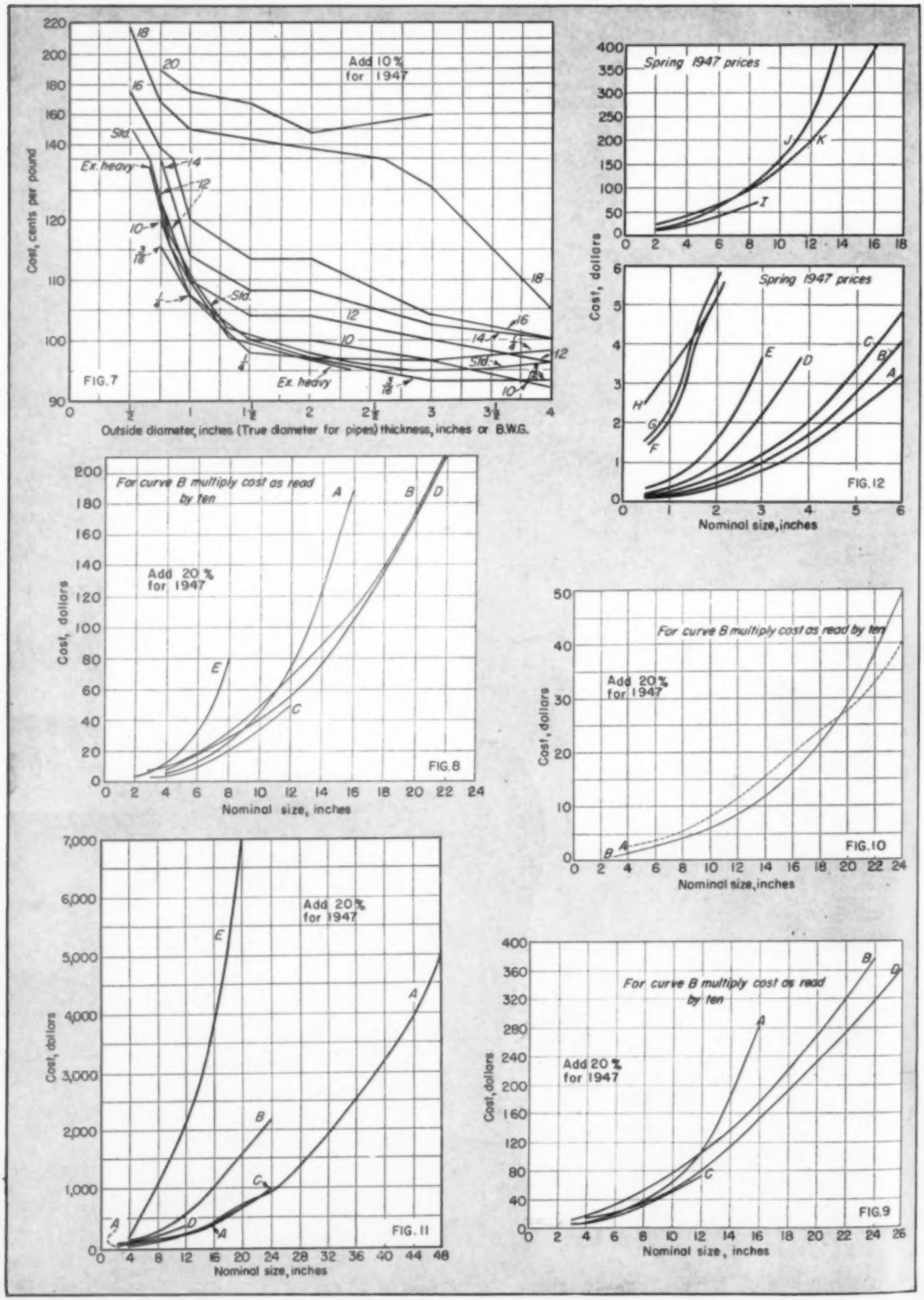
Because of the scale of Fig. 1, another chart with a larger scale has been prepared to show the cost of seamless steel tubing in smaller sizes. Such is the purpose of Fig. 2, which shows the cost in cents per foot as a function of diameter and thickness.

18-8 Stainless Steel—The cost of this metal in seamless tubing and standard and extra heavy pipe is shown in Fig. 3 as a function of diameter and thickness. In the case of the pipes the cost was considered as a function of the true outside diameter only.

Yellow Brass (65 Percent Cu, 35 Percent Zn) and Other Similar Copper Alloys—The cost in cents per pound of yellow brass pipe and tubing is shown in Fig. 4 as a function of the usual variables. The change of ordinate from cents per foot to cents per pound was

Fig. 3—Costs for 18-8 stainless steel pipe and tubing
Fig. 4—Costs for yellow brass pipe and tubing (add 25-50 percent for 1947)
Fig. 5—Costs for Everdur pipe and tubing (add 25-50 percent for 1947)
Fig. 6—Costs for Monel pipe and tubing




Add 10 % for 1947
Cost, cents per pound
Outside diameter, inches (True diameter for pipes) thickness, inches or B.W.G.
FIG. 7
Spring 1947 prices
Cost, dollars
FIG. 12
Nominal size, inches
For curve B multiply cost as read by ten
Add 20 % for 1947
FIG. 8
Nominal size, inches
For curve B multiply cost as read by ten
Add 20 % for 1947
FIG. 10
Nominal size, inches
Add 20 % for 1947
FIG. 11
Nominal size, inches
For curve B multiply cost as read by ten
Add 20 % for 1947
FIG. 9
Nominal size, inches

made to permit the representation of many metals by a common line, since these metals differ in price from one another only by small constant factors, independent of size. For the other metals listed herewith the following figures in cents per pound should be added to the yellow brass cost read on Fig. 4:

Yellow brass (72% Cu)	0.2
Red brass (80% Cu)	0.6
Red brass (85% Cu)	0.8
Red brass (90% Cu)	1.2
Admiralty	2.9
Tobin bronze (60% Cu, 39.25% Zn, 0.75% Sn)	5.3
Copper	−0.9

Since tables of weights per foot of ordinary yellow brass seamless tubing (Badger and McCabe[1], p. 635) and standard pipe ("Chemical Engineers' Handbook"[4], p. 783) are available, it is necessary to have only a table of conversion factors by which the weight of brass tubes can be multiplied to yield the weight of the metal in question. These factors are:

Yellow brass, 72%	1.01
Red brass, 80%	1.02
Red brass 85%	1.03
Red brass 90%	1.04
Admiralty	1.01
Tobin bronze	0.99
Copper	1.05

Everdur 1010 (95.8 Percent Cu, 3.1 Percent Si, 1.1 Percent Mn) and Similar Alloys—The cost of tubing made of this metal as a function of the same variables is shown in Fig. 5. For the other metals the following figures in cents per pound must be added to the cost read on Fig. 5.

Everdur 1015 (98.25% Cu, 1.5% Si, 0.25% Mn)	−16.0
Ambrac (75% Cu, 5% Zn, 20% Ni)	1.3
Super-Nickel (70% Cu, 30% Ni)	6.8
Phosphor bronze (95% Cu, 5% Sn)	−5.8
Phosphor bronze (92% Cu, 8% Sn)	−3.0
Phosphor bronze (89.5% Cu, 10.5% Sn)	−0.3

The conversion factors by which weights of brass tubes must be multiplied to yield the weight of the metal in question are:

Everdur 1010	1.01
Everdur 1015	1.03
Ambrac	1.05
Super-Nickel	1.06
Phosphor bronze, 5%	1.05
Phosphor bronze, 8%	1.04
Phosphor bronze, 10%	1.04

Monel, Nickel and Inconel—The cost of Monel pipe and tubing is plotted in Fig. 6 in the usual manner.

Fig. 7—Costs for Inconel pipe and tubing

Fig. 8—Costs for elbows, various metals

Fig. 9—Costs for tees and crosses

Fig. 10—Costs for cast iron and Ferrosteel flanges

Fig. 11—Costs for gate valves

Fig. 12—Costs for ordinary-service valves and fittings (1947 prices)

For nickel it is necessary to add 10c. per lb. to the costs as shown. The weight of either Monel or nickel tubes or pipes can be calculated from that of the corresponding steel tubes or pipes ("Chemical Engineers' Handbook,"[4] pp. 763, 771) by multiplying by 1.13.

The cost of Inconel pipe and tubing must be presented on another chart, Fig. 7. The ratio of the weights of Inconel tubes and pipe to those of steel is 1.09.

Non-Metallic Piping—Carbon pipe is available in standard 9-ft. lengths, and the costs of such pipe and a few representative accessories are summarized herewith for 1947:

Size	Pipe Cost per Foot	Elbows	Tees	Globe Valves
1 in. I.D.	$1.40	$4.20	$5.30	$40.00
3 in. I.D.	7.00	14.55	15.25	
4 in. I.D.	10.40	21.70	25.15	

Only globe valves are available in this material. However, carbon valves are not made in sizes above 2 in.

Glass pipe (Pyrex) is available in standard lengths of 10 ft. and less. The costs of such pipe in 10-ft. lengths and of a few representative fittings are as follows:

Size	Pipe Cost per Foot	Elbows	Tees	Flanges for Assembly
1 in. I.D.	$0.45	$3.25	$3.35	$0.50
2 in. I.D.	1.03	5.25	5.50	0.80
3-in. I.D.	1.61	8.25	8.50	1.50
4 in. I.D.	3.00	12.50	16.50	3.50

The above prices are brought up to date for 1947 by adding approximately 30 percent. Average discount for quantity purchases is 10 percent.

Fittings

The principal variables which govern the cost of fittings are the construction material, operating pressure, jointing method, external finishing, and size. The last is most convenient for graphical representation, and therefore the costs of specific fittings representative of a group have been plotted against size. Factors are then presented by which the values read from the curve may be multiplied to yield the costs of other fittings within the same group, but differing from the representative one by one or more of the foregoing variables. Such a method implies that fittings whose costs are to be calculated by such factors are available in the same size as the representative one. This is not always the case, and therefore only a manufacturer's catalog and not these figures should be taken as indication that a given type of fitting is available in a certain size. The pressures referred to are water, oil, or gas non-shock ratings, abbreviated W.O.G., for the larger sizes of any one group. The smaller sizes may be used at higher pressures. With steel fittings, however, the pressure rating is only nominal.

Elbows—The cost of elbows as functions of nominal diameter is shown in Fig. 8. Curve A is for malleable iron, 600-lb. pressure, 90-deg. screwed elbows. The factors for other types are as follows:

600 lb. galvanized	1.5
350 lb. malleable	0.64
300 lb. malleable	0.40
300 lb. galvanized	0.53

For 45-deg. elbows of this group, the 90-deg. elbow cost should be multiplied by 1.2.

Curve B (note that the ordinate is to be multiplied by 10) is for alloy cast steel, 900-lb. pressure, 90-deg. and 45-deg., flanged elbows. Factors for other cases are as follows:

Carbon molybdenum (A.S.T.M. A157, Grade C1), 900 lb	Curve B
Chrome molybdenum (A.S.T.M. A157, Grade C5), 900 lb	1.34
Carbon molybdenum, 1,500 lb	1.6
Chrome molybdenum, 1,500 lb	2.1
Carbon molybdenum, 600 lb	0.52
Chrome molybdenum, 600 lb	0.70
Carbon molybdenum, 400 lb	0.37
Chrome molybdenum, 400 lb	0.50
Carbon molybdenum, 300 lb	0.23
Chrome molybdenum, 300 lb	0.31
0.3% Carbon steel (A.S.T.M. A95), 150 lb	0.18

Curve C is for cast iron, 400-lb. pressure, 90-deg. screwed elbows. Factors for other types are:

400 lb., galvanized	2.0
175 lb., cast iron	0.5
175 lb., galvanized	1.0

For 45-deg. elbows, the above figures should be multiplied by 1.2.

Curve D is for cast iron and Ferrosteel (A.S.T.M. A126, Class B), 350-lb., 90-deg. flanged elbows. The factor for 150-lb. pressure rating is 0.67. For 45-deg. elbows in this group, the above figures should be multiplied by 1.1 in small sizes and 1.0 in large sizes.

Curve E is for 400-lb. brass, rough-surfaced, 90-deg. and 45-deg. screwed elbows. Factors are as follows:

400 lb., polished	1.4
200 lb., rough	0.6
200 lb., polished	0.95

Tees and Crosses—The cost of tees and crosses as functions of nominal diameter is shown in Fig. 9. Curve A is for malleable iron, 600-lb. pressure, screwed tees. The factors for others are as follows:

600 lb., galvanized	1.5
350 lb. malleable	0.64
300 lb., malleable	0.34
300 lb., galvanized	0.44

For crosses of the 600- and 350-lb. classes, the corresponding tee cost should be doubled, and for the 500-lb. class, the factor is 1.3.

Curve B (note that ordinate is to be multiplied by 10) is for alloy cast

steel, 900-lb. pressure, flanged tees. Appropriate factors are:

Carbon molybdenum (A.S.T.M. A157, Grade C1), 900 lb	Curve *B*
Chrome molybdenum (A.S.T.M. A157 Grade C5), 900 lb	1.33
Carbon molybdenum, 1,500 lb	1.6
Chrome molybdenum, 1,500 lb	2.1
Carbon molybdenum, 600 lb	0.52
Chrome molybdenum, 600 lb	0.70
Carbon molybdenum, 400 lb	0.37
Chrome molybdenum, 400 lb	0.50
Carbon molybdenum, 300 lb	0.23
Chrome molybdenum, 300 lb	0 31
0.3% Carbon steel (A. S. T. M. A95), 150 lb	0 18

For crosses of all the above classes, the corresponding tee cost should be multiplied by 1.4.

Curve *C* is for cast iron, 400-lb. pressure, screwed tees. Other factors are:

400 lb., galvanized	2.0
175 lb., cast iron	0.5
175 lb., galvanized	1.0

For 400-lb. crosses the tee cost should be multiplied by 1.3, and for 175-lb., by 1.8.

Curve *D* is for cast iron and Ferrosteel, 350-lb., flanged tees. For 150-lb. pressure rating, the cost should be multiplied by 0.67. Crosses cost about 50 percent more than tees in both cases.

Flanges—The costs of flanges are shown in Fig. 10. Curve *A* is for cast iron and Ferrosteel, 350-lb., faced and drilled, screwed flanges. The factor for 150-lb. rating is 0.61.

Curve *B* (note that the ordinate is to be multiplied by 10) is for forged carbon steel (A.S.T.M. A105), 900-lb., faced and drilled, screwed and slip-on welding flanges. For other pressures, the cost should be multiplied by:

1,500 lb	1.4 (small) to 1.8 (large)
600 lb	0.65 (small) to 0.36 (large)
400 lb	0.4 (small) to 0.25 (large)
300 lb	0.27 (small) to 0.2 (large)
150 lb	0.17

For welding neck flanges, the corresponding screwed flange cost should be multiplied by:

1,500 lb	1.2	400 lb	1.6
900 lb	1.4	300 lb	1.3
600 lb	1.6	150 lb	1.4

Valves

Gate Valves—The cost of a gate valve is largely a function of body construction material, trim material (seats and stem), type of gate, pressure, stem arrangement (outside screw and yoke or non-rising stem), jointing method, and size. The last is again most convenient for graphical representation, and therefore Fig. 11 shows the costs of various representative valves as functions of the nominal sizes. The effect of each single variable can be calculated by the factors to follow, and if two or more variables change, two or more of the factors can be multiplied together to give the appropriate correction for all changes. As with fittings, only by consulting the manufacturers' catalogs can one be certain that one of the non-representative valves is available in the same size as the representative one. Whenever possible, limits of availability are mentioned below.

Curve *A* is for iron-body, iron-trimmed, single-wedge, 200-lb. pressure, outside screw and yoke (hereafter abbreviated O.S.&Y.), flanged gate valves. These costs should be multiplied by the following factors for these modifications:

Brass-trimmed	1.0
Screwed (available to 12-in.)	0.9
Non-rising stem (N.R.S.), 2 to 10-in.	0.78
12 to 24-in.	0.85
30 to 48-in.	0.88
Exelloy (11 1/2-13% Cr stainless), trimmed, 2 to 6-in.	1.9
8 to 12-in.	1.8
18-8 stainless-trimmed, 2 to 6-in.	2.0
8 to 12-in.	1.9
50-lb. pressure (available only in flanged valves, all-iron or brass-trimmed,)	0.86
Malleable iron body (available only below 8-in., all iron or brass-trimmed)	1.7

Curve *B* is for Ferrosteel (A.S.T.M. A126, Class B) iron-trimmed, single-wedge, 400-lb., O.S. & Y., flanged gate valves. Other factors are:

Brass-trimmed	1.0
Screwed valves (available only to 12-in.)	0.97
N.R.S., 2 to 10-in.	0.85
12 to 24-in.	0.93
800-lb. pressure	3.0

Curve *C* is for iron-body, iron-trimmed, double-disk, 150-lb., O.S.&Y., flanged gate valves. Factors for modifications are as follows:

Brass-trimmed	1.0
Screwed, less than 6-in.	0.96
6 to 12-in.	1.0
N.R.S., less than 12-in.	0.8
over 12-in.	0.87
160-lb. pressure	0.75
35-lb. pressure	0.68

Curve *D* is for Ferrosteel (A.S.T.M. A126, Class B) body, iron-trimmed, double-disk, 400-lb. pressure, O.S.&Y., flanged gate valves. For modifications these factors apply:

Brass-trimmed	1.0
Screwed	0.98
N.R.S.	0.8
500 lb., less than 8-in.	1.15
more than 8-in.	1.33
800 lb., 2 to 4-in.	1.5
6 to 8-in.	1.9
10 to 12-in.	2.8

Curve *E* is for cast steel body, Exelloy-trimmed, single-wedge, 600-lb. (nominal) pressure, O.S.&Y., flanged gate valves. Other multipliers are:

1,500 lb	1.9 (small) to 2.7 (large)
900 lb	1.7 (small) to 1.5 (large)
400 lb	0.83 (small) to 0.65 (large)
300 lb	0.71 (small) to 0.37 (large)
150 lb	0.5 (small) to 0.25 (large)
Screwed (available only to 6-in. and not at all above 300 lb.)	0.95
Hub ends for welding	1.0
Body of chrome-molybdenum steel (4-6% Cr, A.S.T.M. A157, Grade C5)	1.1
18-8 stainless-trimmed	1.2

Ordinary-Service Valves and Fittings—A considerable portion of plant piping is used in ordinary low-pressure service for water, steam, and non-corrosive fluids. Current costs (Spring 1947) for valves and fittings for these applications are shown in Fig. 12. These fittings and valves are rated for 125 lb. steam pressure and may be specified for general low pressure service. Curves *A* through *D* represent screwed cast-iron fittings as follows: *A*, 90-deg. elbows; *B*, 45-deg. elbows; *C*, tees; *D*, crosses. Curve *E* is for malleable iron unions with iron-to-iron or iron-to-brass seats. Curve *F* represents screwed bronze check valves in sizes ¼ to 2 in. and *I* is for flanged all-iron, swing-type check valves from 2 to 8 in. Curve *G* is for screwed bronze globe and angle valves in sizes from ¼ to 6 in. while Curve *J* is for flanged, yoke-top, iron-body, brass- or iron-trim globe and angle valves in sizes from 2 to 14 in. Gate valve costs are given in Curves *H* and *K*. Curve *H* covers screwed, all-iron, single-wedge O. S. & Y. gate valves in sizes ¼ to 6 in. Curve *K* is for flanged, all-iron, single-wedge O. S. & Y. gate valves in sizes from 2 to 16 in.

Heat Exchangers

Cost of heat exchangers depends on the material, diameter, thickness, and length of tubes, material and size of tube sheets, material, size, and thickness of shell and such special features of design as floating heads and baffles, etc. Obviously no simple method could be derived by which the effect of all these variables on cost could be predicted. Therefore, this correlation has been limited to include only the effect of tube construction material and dimensions on total cost. The shell has been assumed to be fixed at a common and widely used type, i.e., steel, 150-lb. pressure, floating head, with an average number of baffles and satisfying the A.P.I.-A.S.M.E. construction code.

Even with such a limitation graphical presentation of heat exchanger costs in the most useful form, i.e., cost in dollars per square foot vs. total heat transfer area, would require different graphs for each possible construction material of the tubes, and each graph would require various tube diameters, thicknesses, and lengths as parameters. To obviate this multiplicity of figures and curves, except for a few commonly used metals and sizes, the following method has been evolved which would be suitable for almost any tube material. The cost of any exchanger is assumed to be made up of the tube cost and the shell cost, the latter including headers,

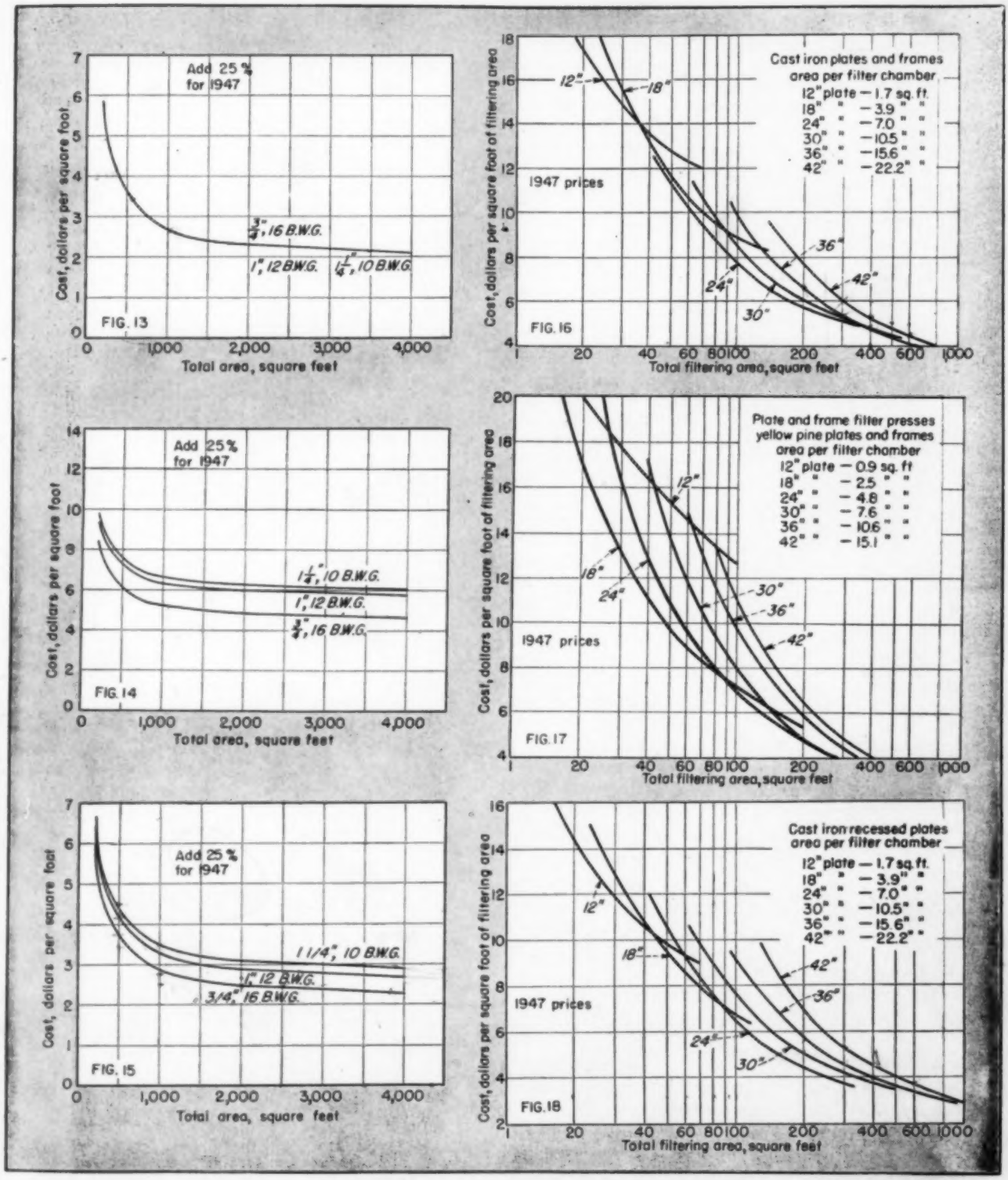

Add 25 % for 1947
Cost, dollars per square foot
Total area, square feet
3/4", 16 B.W.G.
1", 12 B.W.G.
1 1/4", 10 B.W.G.
FIG. 13
Add 25 % for 1947
Cost, dollars per square foot
Total area, square feet
1 1/4", 10 B.W.G.
1", 12 B.W.G.
3/4", 16 B.W.G.
FIG. 14
Add 25 % for 1947
Cost, dollars per square foot
Total area, square feet
1 1/4", 10 B.W.G.
1", 12 B.W.G.
3/4", 16 B.W.G.
FIG. 15
Cast iron plates and frames
area per filter chamber
12" plate — 1.7 sq. ft.
18" " — 3.9 " "
24" " — 7.0 " "
30" " — 10.5 " "
36" " — 15.6 " "
42" " — 22.2 " "
1947 prices
Cost, dollars per square foot of filtering area
Total filtering area, square feet
FIG. 16
Plate and frame filter presses
yellow pine plates and frames
area per filter chamber
12" plate — 0.9 sq. ft
18" " — 2.5 " "
24" " — 4.8 " "
30" " — 7.6 " "
36" " — 10.6 " "
42" " — 15.1 " "
1947 prices
Cost, dollars per square foot of filtering area
Total filtering area, square feet
FIG. 17
Cast iron recessed plates
area per filter chamber
12" plate — 1.7 sq. ft.
18" " — 3.9" "
24" " — 7.0" "
30" " — 10.5" "
36" " — 15.6" "
42" " — 22.2" "
1947 prices
Cost, dollars per square foot of filtering area
Total filtering area, square feet
FIG. 18

Fig. 13—Costs for heat exchangers, steel tubes
Fig. 14—Costs for heat exchangers, 18-8 stainless tubes
Fig. 15—Costs for heat exchangers, Admiralty tubes

Fig. 16—Costs for cast iron plate-and-frame filters
Fig. 17—Costs for filters with pine plates and frames
Fig. 18—Costs for C.I. recessed plate filter presses

baffles, etc. The former can be estimated for any number of tubes of any diameter, thickness, and material by the methods discussed under Pipe and Tubing. The latter can be estimated by the following figures:

Total Heat Transfer Area	Cost of Shell per Sq. Ft. of Heat Transfer Area
200 Sq. Ft	$5.25
500	3.00
1,000	2.10
2,000	1.70
3,000	1.60
4,000	1.50

For 1947 add about 30 percent. In general, the over-all increase in heat exchanger costs from the Fall of 1945 has been from 15 to about 30 percent, depending on design and maker. The Bureau of Labor Statistics shows

a 21.8 percent increase for this period.

It should be emphasized that this shell cost assumes the construction details listed previously. Area as used here refers to outside tube area. For types substantially different, manufacturers should be consulted. The effects of a few variations have been observed and can be noted, but they are only approximations.

	Multiply Shell Cost by
For 4–16 chrome steel construction	4.0 to 6.0
For 18–8 stainless steel construction	8.0 to 9.0
For fixed head construction	0.7
For 75-lb. pressure	0.9
For 300-lb. pressure	1.2

The more useful form of presentation, i.e., cost per square foot vs. total area in square feet, is shown in Figs. 13, 14 and 15, for heat exchangers with tubes of seamless steel, 18-8 stainless steel, and Admiralty and with shell construction as outlined. Costs for three representative tube dimensions are given. No attempt to separate the individual effects of tube diameter and thickness is made, because such effects can best be determined by the more elaborate method. It is apparent that even the more elaborate method will not predict the effect of tube length (which effect is small), because this a matter of shell cost, and shell cost has been correlated on the basis of total heat transfer area and not the shell dimensions. Therefore, the effect of length is not shown on these figures.

Filters

Filter Presses—The costs of plate-and-frame presses of cast iron and of yellow pine, and those of cast iron recessed-plate presses are shown in Figs. 16, 17, and 18. These costs are current, not 1945. For presses of other metals the cast iron cost should be multiplied by the following factors:

Aluminum	1.70
Bronze	2.75
Lead	2.50
18–8 Stainless	5.50

Sweetland—The cost of Sweetland filters is shown in Fig. 19 as functions of total area and leaf spacing. These curves are for cast iron Sweetland filters with cotton filter cloth and without accessories. Since the area of these presses is determined by the use of discrete numbers of leaves and not any variable number, the presentation of these costs as continuous curves is somewhat misleading, and they should be used only in conjunction with manufacturers' catalogs so that the area and standard sizes are known.

Oliver Continuous Vacuum Filters—The cost of these filters can be represented as functions of total drum area as in Fig. 20. These costs are for steel and wood drum Oliver filters with steel tank, vacuum receiver, trap, and feed and vacuum pump. Motors are excluded.

The following approximate installation and accessories costs may be cited:

	Installation, Percent	Accessories, Percent
Sweetland	30	25
Plate-and-frame	30	25–30
Oliver	30	Included in curve

Vessels and Columns

Fowler and Brown[7] presented a thorough review of pressure vessels and pressure fractionating columns, with costs, as of early in 1941. An abridged treatment of their results will be given here in which cost figures are brought up to date for the spring of 1947. Generally, costs changed little from 1941 to 1945, but from 1945 to 1947 there was an overall increase of approximately 25 percent while individual items such as manholes and nozzles went up about 50 percent. The data of Figs. 21 to 25 inclusive have been kept on a 1945 basis and should be increased 50 percent for 1947.

Fowler and Brown itemized the total cost of such equipment which includes the following: (1) Vessel shell, including heads, skirt, hand- and manholes, nozzles, tray supports, and stress relief; (2) bubble trays; (3) platform, ladders, and handrails; (4) insulation. Their costs were computed on the basis of actual quotations for specific installations, and therefore no errors in estimating or waste were included. For estimating purposes they suggested adding 10 percent to the costs discussed herewith.

The shell, heads, and skirt may be computed from the weight thereof at a unit cost of $0.09 per lb. for steel and $0.15 per lb. for molybdenum steel (A.S.T.M. A204, firebox quality). Alloy liners (A.S.T.M. A176, type 410) for the shell should cost $6.50 to $9.50 per sq. ft. for 5/64-in. thickness and $7.00 to $10.00 for 7/64-in. thickness. Tray angles cost about $0.50 per lb. for steel and $1.25 for type 410 stainless.

Manholes

Manholes contribute markedly to the cost as Figs. 21, 22, and 23 show. In these figures only 300-lb., 400-lb. and 900-lb. ratings are shown. Approximate costs for the 150-lb. class may be determined by multiplying the corresponding cost in the 300-lb. class by 0.92, although the 150-lb. class is not ordinarily available for shell thicknesses greater than 1¼ in. Similarly, approximate costs for the 600-lb. class may be determined by multiplying the 900-lb. figure by 0.73, although the 600-lb. group is not ordinarily made for vessel thicknesses above 3 in. It should be noted that these costs are for the installed manhole.

The installed cost of handholes may be taken as approximately $105 for 8-in. handholes, increasing linearly to about $285 for the 16-in. size.

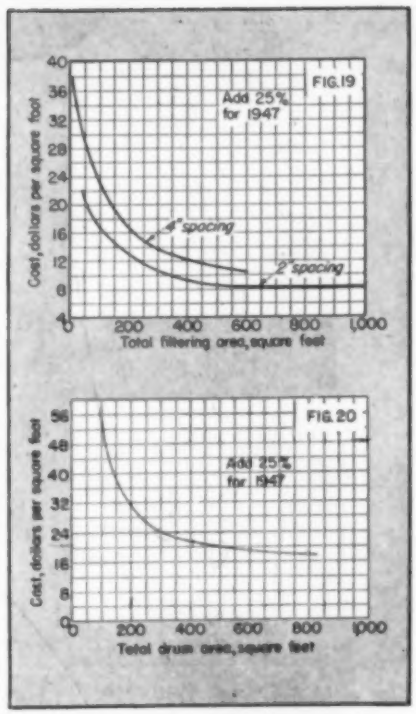


Fig. 19—Costs for cast iron Sweetland filters, cotton cloths

Fig. 20—Costs for steel and wood Oliver filters, less motors

Nozzles

The installed cost of nozzles is given in Figs. 24 and 25. The cost of 150-lb. rating nozzles can be approximated by multiplying the 400-lb. curve by 0.86, and the cost of 300-lb. nozzles can be estimated by multiplying the same curve by 0.93. The figures for 600-lb. nozzles may be estimated by multiplying the 900-lb. figures by 0.96, although the 600-lb. class is not ordinarily made for vessel thicknesses in excess of 3 in.

Alloy liners (same composition as shell liners) for nozzles and manholes are available at about $0.20 per sq. in.

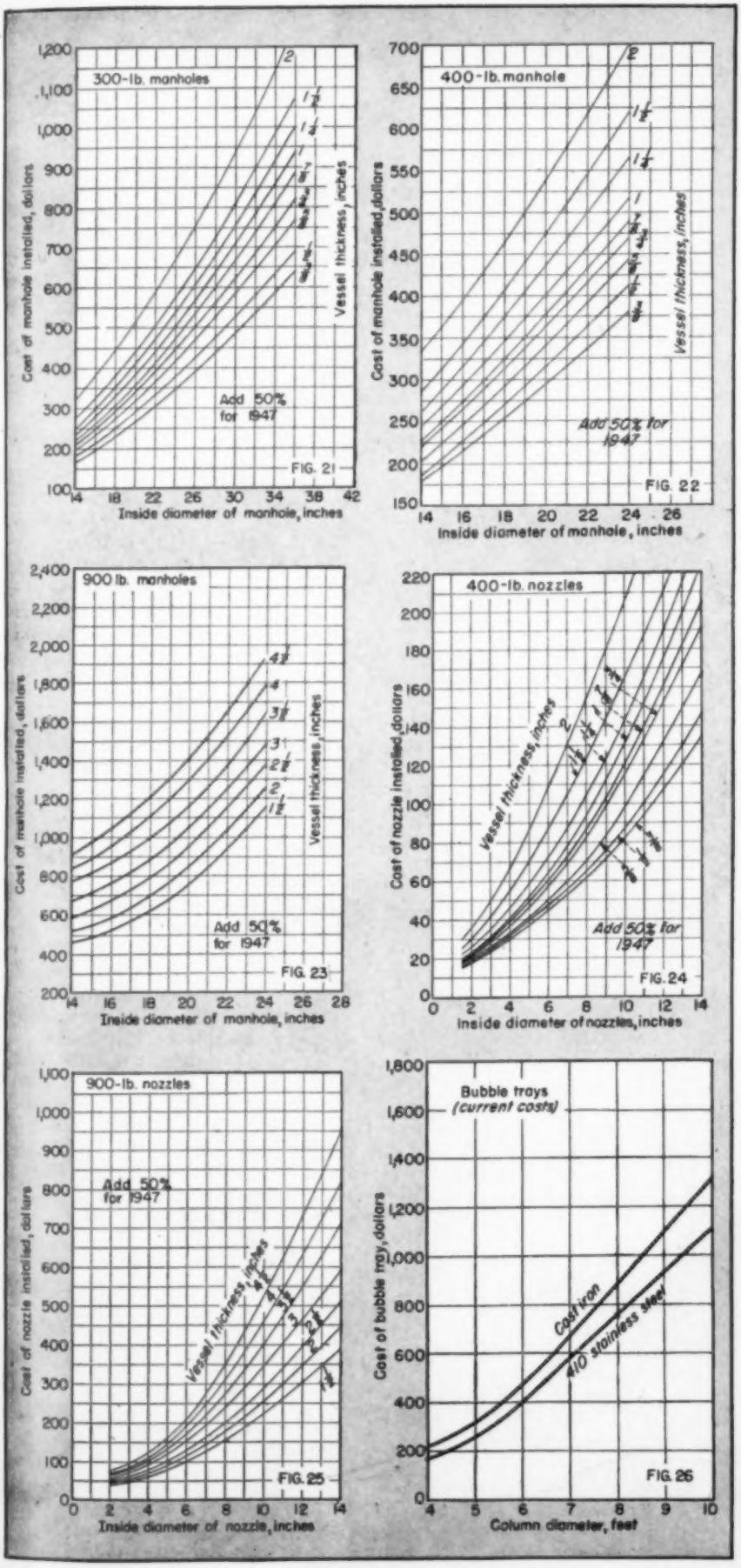


FIG. 21 FIG. 22 FIG. 23 FIG. 24 FIG. 25 FIG. 26

The installed cost of couplings is about \$7.50 for 1-in. size varying approximately linearly to about \$30 for 4-in. size.

Tray supports, if the shell is to be used as a column, may be estimated at \$0.50 per lb. for steel and \$1.25 per lb. for 410 stainless. The necessary weights are as follows:

Column Diameter, Ft.	Weight of Alloy Tray Supports, Lb.
4	75
5	100
5½	120
6	140
7	180

The cost of stress relief may be estimated as 1 percent of the sum of all items above which make up the complete shell, not to exceed \$500. X-ray inspection should be reckoned at about 3 percent.

The cost of a bubble tray (Spring 1947) is shown in Fig. 26. This gives the installed cost and includes decks, downpipes, bubble caps, packing, and bolts. Present high cost of cast iron trays is partly due to the fact that the price of cast iron has increased roughly 300 percent in the past two years.

External column fittings, such as ladders, handrails, and platforms may be estimated as costing \$0.125 per lb. A ladder should weigh about 30 lb. per ft. and the platform and handrails from about 1,250 lb. for a 2½-ft. diameter column to 3,700 lb. for an 11-ft. column, approximately linear interpolation being permissible.

Total installed cost of column insulation is about \$1.30 per sq. ft. for 1½-in. thickness to \$1.70 per sq. ft. for 5-in. thickness.

Thickeners and Classifiers

Prepared currently by engineers of the Dorr Co. to permit the approximate estimation of continuous thickeners and mechanical classifiers produced by that concern, this section permits estimators to gain a general idea of cost ranges, as of May 1947, although the figures so obtained must be used with caution, for rough preliminary estimates only, to be confirmed at the first opportunity by manufacturers' quotations.

Thickeners—The continuous thick-

Fig. 21—Costs for 300-lb. manholes

Fig. 22—Costs for 400-lb. manholes

Fig. 23—Costs for 900-lb. manholes

Fig. 24—Costs for 400-lb. nozzles

Fig. 25—Costs for 900-lb. nozzles

Fig. 26—1947 costs for bubble trays

eners used in the chemical and allied process industries may be grouped in three basic types: the unit or single compartment thickener; the two-compartment, or single-tray thickener; and the three-compartment, or two-tray thickener. Each compartment of a multiple tray thickener adds just that much additional settling area which may be used (*a*) for increasing the capacity, if the trays are operated in parallel, or (*b*) for countercurrent washing of the settled solids, if the trays are operated in series. The most commonly used sizes range between 30 and 60 ft. in diameter with varying depths, 10 to 30 ft., depending upon the number of compartments provided.

The figures given below are in dollars per square feet of settling area, since area is the factor that determines capacity on any given pulp or slurry. The figures cover a complete thickener in each case—mechanism, motor drive unit, open steel tank and, if a tray-type thickener, the required number of trays and accessories. Figures are based on shipment, knocked down, f.o.b. factory, exclusive of erection, foundations, etc.

Single-Compartment Thickeners (30-60 ft. dia.)
Average unit cost $5.25 per sq. ft. settling area
Range ± 5-10 percent
Two-Compartment Tray Thickeners (30-60 ft. dia.)
Average unit cost $4.85 per sq. ft. settling area
Range ± 10-15 percent
Three-Compartment Tray Thickeners (30-60 ft. dia.)
Average unit cost $4.50 per sq. ft. settling area
Range ± 10-15 percent

Price range, expressed as a percentage of average unit cost, covers sizes from 30 to 60 ft. in diameter, the greater unit cost applying to the smaller machines and the lower unit cost to the larger ones. Large thickeners are more economical in first cost, as shown; and also, not shown, in erection and operation per square foot of area or per ton of rated daily capacity.

Relative Costs

The average unit cost of a two-compartment (single-tray) thickener is about 7½ percent less than that of a single compartment thickener having the same settling area or same rated capacity. A three-compartment (two-tray) thickener likewise costs about 7½ percent less than a two-compartment (single-tray) thickener and about 15 percent less than a single-compartment thickener, all three of which have the same settling areas and same rated capacities, provided the most efficient type of tray is used. Tray-type thickeners are the most economical type and the economies become more and more marked as more trays are added, up to four or five.

Units less than 30 ft. in diameter command a much higher price per square foot than the averages shown. Units larger than 60 ft. in diameter are usually furnished only in the single-compartment type and generally at a unit cost somewhat less than the average given. Any special design features, including the use of special materials of construction, so completely change the cost structure that the round average figures given are valueless in such cases.

Mechanical Classifiers—The mechanical rake classifiers most generally used in the chemical and allied processing industries, may be grouped in two types, normal- and heavy-duty, and four widths, 4, 6, 8 and 12 ft. The three smaller units are of the duplex type, with two sets of reciprocating rakes; while the largest unit, 12 ft. wide, is of the quadruplex type, with four sets of reciprocating rakes. Classifiers of this type are available, of course, in other sizes as well—from light-duty, duplex units 1 ft. 2 in. wide, to heavy-duty, quadruplex units 16 ft. wide.

Both overflow and sand-raking capacities are functions of the width of the tank, so average costs, for preliminary, rough estimates only, are expressed as dollars per linear foot of width. Broadly, the finer the mesh of separation, the less is the speed of the rakes, the greater the overflow dilutions and the less the overflow and sand raking capacities. The figures given below cover a complete classifier in each case, of average length—mechanism, motor drive unit and steel tank, fully assembled, f.o.b. factory, exclusive of erection and foundation.

Normal-Duty Mechanical Classifiers (4-12 ft. wide)
Average unit cost $815 per ft. of width
Range ± 5-10 percent
Heavy-Duty Mechanical Classifiers (4-12 ft. wide)
Average unit cost $1,375 per ft. of width
Range ± 5-10 percent

Price range, expressed as a percentage of average unit cost, covers the range in width given, the greater unit cost corresponding to the smaller machines, and vice versa. Broadly, the normal-duty classifier is adequate for most problems encountered in the chemical and process industries where the duty is generally less severe than in the metallurgical industry, for which the heavy-duty classifier was designed. However, the use of the heavy-duty type is recommended for phosphate rock washing, bauxite preparation, sand and gravel and wet process cement grinding, and other fields of comparable severity.

The nature of the material to be handled, the mesh at which a separation is to be made and the dimensions of the grinding mill, if one is to be used, greatly affect speed, size and tank slope, which in turn affect the length and cost of the classifier. Any special design features, including the addition of a bowl, ranging from classifier width up to 28 ft. in diameter, so completely change the cost structure that the round average figures are valueless, even for rough estimates.

Evaporators and Crystallizers

Cost per square foot of heating surface of horizontal tube, basket, and calandria type evaporators is shown as a function of total area in Fig. 27. Such costs are for cast iron construction with copper heating surfaces, complete with piping, condenser, and pumps, but without motors and supporting framework. This might be called standard construction, and for certain deluxe features, such as corrosion resistant fittings, about 25 to 30 percent should be added to the costs illustrated in Fig. 27. An average number of effects is assumed in arriving at the prices.

The cost of long tube vertical film type evaporators is shown in Fig. 28. The upper curve is for cast iron construction with copper heating surface, and the lower curve is for all welded steel construction, both with accessories as above. An additional cost of about 10 percent should be allowed for deluxe features.

The cost of forced circulation evaporators is shown in Fig. 29. The upper curve is for nickel cast iron construction with nickel heating surface, and the lower curve is for cast iron bodies with copper heating surface, both with accessories as above. For deluxe features, about 25 percent should be added. In the correction for 1947 the greater quantity of skilled labor required for evaporators of this type can be noted in the greater price increase.

The cost of steel crystallizers (Swenson-Walker type), complete with suitable drives may be estimated as shown in the table on the following page. About 20 percent should, however, be added for 1947 estimates.

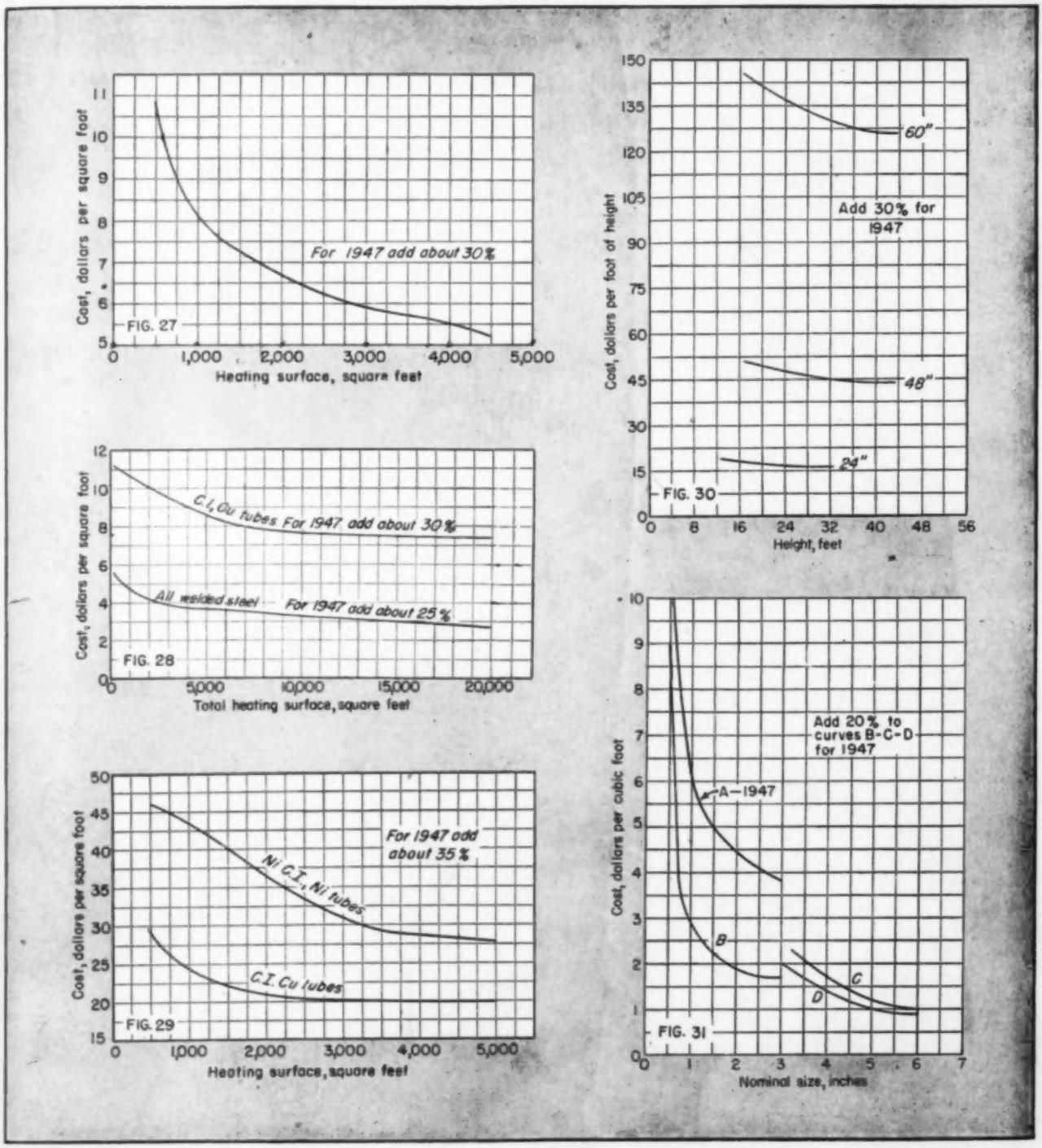


Fig. 27—Costs for horizontal tube, basket and calandria type evaporators

Fig. 28—Costs for long tube vertical evaporators

Fig. 29—Costs for forced circulation evaporators

Fig. 30—Costs for chemical stoneware towers

Fig. 31—Costs for carbon and stoneware tower packings

Total Length Crystalliser, Ft.	Dollars per Ft. Length
20	90
60	70
90	67
120	60
240–360	58
400–800	55
1,000–1,200	54

These are usually built in units 10 ft. long, a maximum of four of which may be connected in series and driven from one shaft. Greater lengths are attained by installation of the quadruple units one above another.

Absorption Towers and Packings

Costs of steel absorption towers may be computed as described above for pressure vessels and columns. The cost of chemical stoneware towers per foot of height is shown in Fig. 30 as functions of nominal diameter and tower height. Aluminum towers may be estimated at about $1.25 per lb. These costs are without piping and accessories which, of course, must be estimated by methods previously discussed. Erection costs will equal or exceed the cost of the tower itself in small sizes and will approximate 25 to 50 percent of the tower cost in large sizes.

The cost of carbon and stoneware

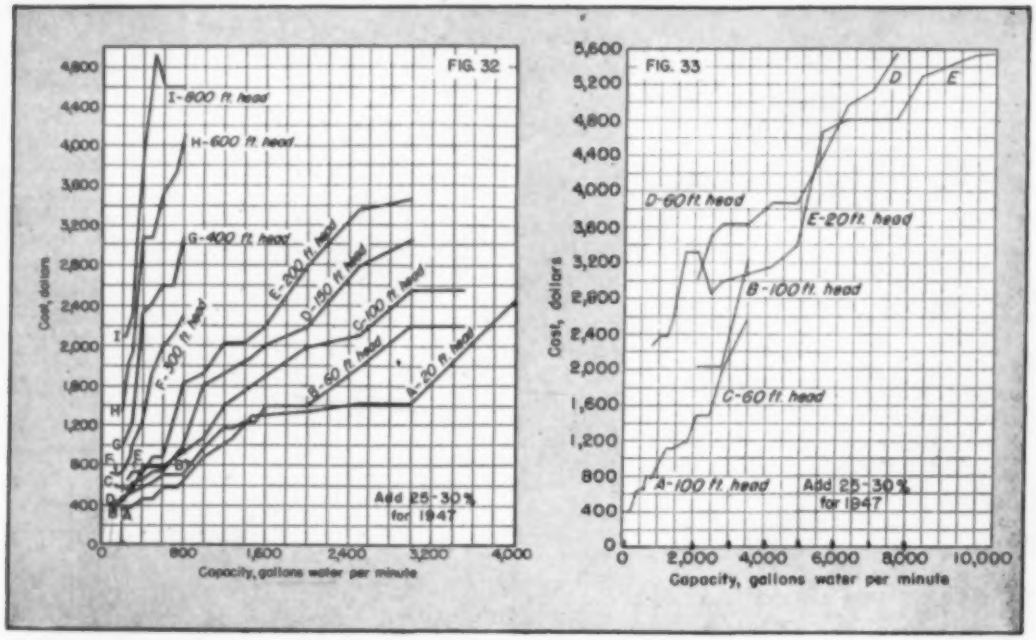


Fig. 32—Costs for standard, inclosed impeller centrifugal pumps with motors
Fig. 33—Costs for horizontal, non-clogging, standard centrifugal pumps with motors

rings in dollars per cubic foot is shown as a function of nominal size in Fig. 31. Curve *A* is for carbon Raschig rings and Curves *B*, *C*, and *D* are for stoneware Raschig, partition, and spiral rings. Porcelain Raschig rings cost about 15 to 30 percent more than stoneware, the higher figure referring to the smaller sizes, and aluminum rings about 3½ times as much. Berl saddles cost about 2½ times as much as stoneware, but they are not usually available above 1½-in. size.

Tanks and Storage Vessels

Steel tanks for storage and other uses are quite variable in cost, depending on pressure, design for economical use of plates, connections required and other factors. For example, mass-produced carbon steel tanks with a minimum of fittings, for hot water pressure service, are priced in the range from about 16 c. per lb. for vessels of 100 lb. weight, to about 7½ c. per lb. for 10,000 lb. weight. Galvanized vessels cost about twice as much. Horizontal steel storage vessels for chemical plant use at nominal pressure cost about the same for the larger vessels, and about 25 percent more for the smallest. However, Happel, Aries and Borns[8] found the cost of carbon steel vessels ranging from 30-50 c. per lb. for vessels of 500 lb., to 8-15 c. per lb. for 50,000-lb. vessels. These averages included Code-fabricated vessels.

Cost of wooden tanks, complete with hoops and connectors but not erected may be estimated as follows:

Quantity, Board, Ft.	Cost per Board Ft. Cypress and Redwood	Cost per Board Ft. Fir and Yellow Pine
500	$0.45	$0.36
1,000	0.42	0.34
2,000 (and over)	0.35	0.32

A board foot is 1 sq. ft., 1 in. thick. Costs should be increased by about 8 percent to include galvanized fittings. Erection costs should be about 40 to 60 percent of the tank cost, but for tanks below about 400 gal. the erection cost will probably approach 100 percent of the tank cost.

For present estimates of wood tanks the 1945 figures given should be increased in the range from 30 to 50 percent, owing to large but locally variable lumber price increases.

Liquid Pumps

Centrifugal—The cost of centrifugal pumps is largely a function of construction material, type (ordinary, non-clogging, sump, etc.), discharge head at rated capacity, rated capacity, speed, number of inlets per impeller, number of stages, and the casing split arrangement (horizontal or vertical). The last three variables were found to be unimportant and were neglected. This does not imply that the number of stages does not have an important effect on the cost of pumps, but rather that it is not a variable independent of discharge head, already considered. Thus to reach a given head, a certain number of stages is required and if the cost has already been shown as a function of head, there is no further major effect of staging. The principal variables above are the capacity, speed and head, and costs for various construction materials and types can be presented graphically as functions of those variables.

Fig. 32 shows the costs with motor and starter of ordinary inclosed-impeller pumps with cast iron casing, bronze wearing rings and impeller, and steel shaft as functions of rated capacity, head, and speed. Because of the many variations among manufacturers, deviations of quotation from these curves as large as 20 percent may be expected. The conditions for each of the curves of Fig. 32 and the effects of variations in a certain range are:

Curve *A* is for single-stage, 20-ft. head, 860 r.p.m.
For 1,150 r.p.m. multiply by 0.92 below 750 g.p.m. and by 0.75 for 1,000–1,500 g.p.m.
For 680 r.p.m. multiply by 1.4 above 400 g.p.m.
For 600 r.p.m. multiply by 1.46 above 1,000 g.p.m.
Curve *B* is for single-stage, 60-ft. head, 1,150 r.p.m.
For 1,750 r.p.m. multiply by 0.75 below 2,000 g.p.m.
For 860 r.p.m. multiply by 1.1 above 1,000 g.p.m.
Curve *C* is for single-stage, 100-ft. head, 1,150 r.p.m.
For 1,750 r.p.m. multiply by 0.80 below 600 g.p.m. and by 0.9 above 1,000 g.p.m.
Curve *D* is for single-stage, 150-ft. head, 1,750 r.p.m.
For 3,450 r.p.m. multiply by 1.0 below 500 g.p.m.
For multi-stage multiply by 1.24 below 300 g.p.m.
Curve *E* is for single-stage, 200-ft. head, 1,750 r.p.m.
For 3,450 r.p.m. multiply by 1.0 below 500 g.p.m.
For multi-stage multiply by 1.32 below 800 g.p.m.
Curve *F* is for multi-stage, 300-ft. head, 1,750 r.p.m.
For 3,450 r.p.m. multiply by 1.1 below 600 g.p.m.
Curve *G* is for multi-stage, 400-ft. head, 1,750 r.p.m.
Curve *H* is for multi-stage, 600-ft. head, 1,750 r.p.m.
Curve *I* is for multi-stage, 800 ft. head, 1,750 r.p.m.

The cost of a pump of alternate construction materials can be esti-

mated by multiplying the standard construction cost by the factors shown below. (It should be observed that these factors are to be applied to the net pump cost and therefore the motor and starter cost must be subtracted from the costs of Fig. 32 before applying these factors):

All-iron	1.05
Ni-Resist casing and trim	1.10
All-bronze	1.50
Everdur	1.5 to 1.75
Monel or 18-8 stainless	
Shafts and sleeves	1.2
Wearing rings	1.2
Impeller	1.2
All-Monel or all-stainless	3 to 5
Nickel	4 to 6
Illium	5 to 7
Stoneware, lead (available only in low head, small sizes)	2 to 3
Rubber-lined (low-head, large sizes)	2
Hastelloy	7 to 9
Inconel	5 to 7

The smaller figure usually refers to the more expensive units and the larger figure to the less expensive ones. It is important to observe in the case of stainless steels, however, that variation in cost of different grades is included.

Another centrifugal pump in wide use is the horizontal non-clogging type, which may be open or closed impeller. The costs of this type with motor as functions of rated capacity and head at rated capacity are shown in Fig. 33. The factors for other construction materials previously mentioned should apply to this type and in addition manganese steel (usually used only for the non-clogging type) can be supplied at approximately twice the standard cost.

The curves of Fig. 33 are as follows:

Curve *A* is for 100-ft. head, 1,750 r.p.m.
Curve *B* is for 100-ft. head, 1,150 r.p.m.
Curve *C* is for 60-ft. head, 1,150 r.p.m.
For 1,750 r.p.m. multiply by 0.75 below 800 g.p.m.
Curve *D* is for 60-ft. head, 700 r.p.m.
Curve *E* is for 20-ft. head, 435 r.p.m.
For 690 r.p.m. multiply by 0.4 below 2,000 g.p.m. and by 0.75 from 2,000 to 4,000 g.p.m.
For 575 r.p.m. multiply by 0.45 below 2,000 g.p.m. and by 0.8 from 2,000 to 4,000 g.p.m.
For 490 r.p.m. multiply by 0.85 below 8,000 g.p.m.

A third centrifugal pump in wide use is the non-clog sump pump. This is merely a non-clogging single-suction centrifugal pump placed at the bottom of the sump with vertical shaft connecting to a motor at the top. The cost of such pumps in cast iron with motors included is shown in Fig. 34. The standard depth is 6 ft. and the cost increases by about 10 percent for each additional 6 ft. or fraction thereof. These additions are for added material alone and do not allow for the increased cost of larger motors required. This must be estimated separately.

Rotary—The costs of cast iron rotary pumps without motors are presented in Fig. 35 as functions of maximum rated capacity and discharge head. The maximum is stressed because rotary pumps are positive displacement pumps and can be run at any reasonable speed to yield a corresponding capacity. The speed chosen for this correlation is the maximum rotational speed as recommended by the manufacturer, which will of course decrease with increased pump size. In Fig. 35 Curve *A* is for gear pumps at 50-lb. pressure, and Curves *B*, *C*, and *D* are for double helical types at the pressures indicated. The effects of certain modifications can be approximated as follows:

All-bronze construction, multiply by	2.0
Speed reducers included (ready for motor)	1.2

Reaction Vessels

It is extremely difficult to generalize on the cost of agitated reaction vessels because they are subject to extremely wide possible variations in pressure rating, heating method, type of construction, drive, and in many other features. Crude average figures can be cited, however. Thus, for a jacketed steel reaction vessel of 500-gal. capacity for 50-lb. steam pressure, or below, with an anchor agitator of moderate speed, an installed cost of about $4,500 would represent a reasonable average. This would include erection, piping, electrical work, and other such matters but would ordinarily exclude instruments. For a 2,000-gal. vessel the figure should be increased to about $6,000. Glass-lined vessels are more expensive, of course, but not as much as one might expect when installation costs are included. Thus a 500-gal. glass-lined reaction vessel, installed, should cost about $5,500 and a 2,000-gal. one about $8,000. (Add about 15 percent for 1947.)

Electric Motors

Cost of electric motors may be represented by an equation of the form Cost (Dollars) = $A + B \times$ Horsepower. The values of A and B for a few types of motors are approximately:

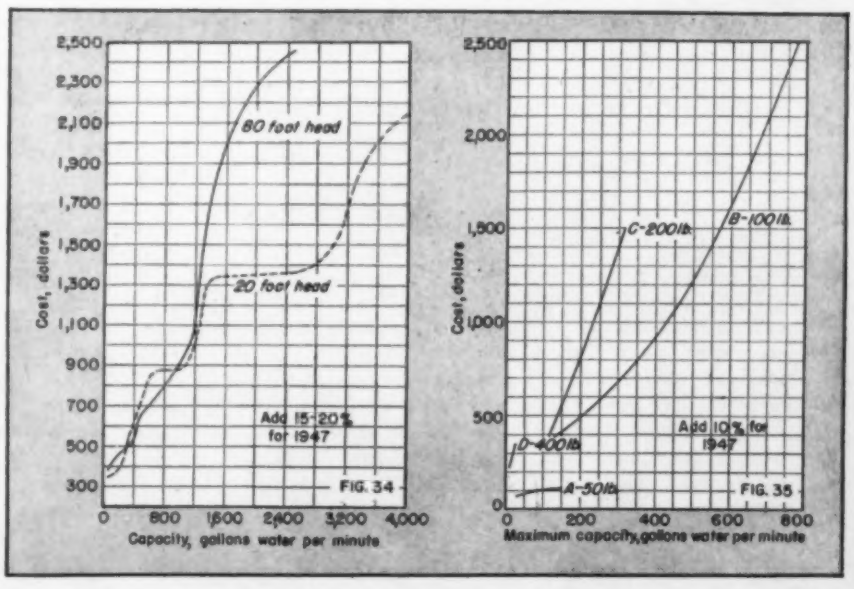
Type	*A*	*B*
Open construction, general purpose, 220–440–550 volts, 3-phase, 60-cycle, 1,800 r.p.m.	$40	$6.6
Same, except 514 r.p.m.	240	12.0
Totally inclosed for Class 1, Group D location, 220–440–550 volts, 3-phase, 60-cycle, 1,800 r.p.m.	60	12.0
Same, except 600 r.p.m.	270	20.6

All these figures are for ball-bearing motors without base or pulley. It is difficult to generalize on starting equipment, but the most costly starters vary between $20 per hp. in small sizes (approximately 10 hp.) and $6 per hy. in larger sizes (about 200 hp.). Increase estimates about 25 percent for 1947.

Acknowledgment

The above work could not possibly have been done without the excellent cooperation of a number of manufacturers. The writer wants particularly to acknowledge the help of these firms: Allegheny Ludlum Steel Corp.; Allen Billmyre Co.; Alliance Tank Co.; Allis-Chalmers Mfg. Co.; American Brass Co.; American Locomotive Co.; American Smelting & Refining Co.; Babcock and Wilcox Tube Co.; C. O. Bartlett

Fig. 34—Costs for cast iron rotary pumps without motors
Fig. 35—Costs for cast iron sump pumps with motors



& Snow Co.; Black, Sivalls & Bryson, Inc.; Buflovak Equipment Division; Corning Glass Works; Crane Co.; Denver Equipment Co.; Dorr Co.; Economy Pumps, Inc.; Peter A. Frasse & Co.; General Electric Co.; Globe Steel Tubes Co.; Goulds Pumps, Inc.; Griscom-Russell Co.; Hardinge Co.; Ingersoll-Rand Co.; International Nickel Co.; Jeffrey Mfg. Co.; Jenkins Bros.; Kinney Mfg. Co.; Lammert & Mann Co.; Lapp Insulator Co.; Lukens Steel Co.; Lummus Co.; National Carbon Co.; National Tube Co.; New England Tank & Tower Co.; Oliver United Filters, Inc.; Pfaudler Co.; Proctor & Schwartz, Inc.; Roots-Connersville Blower Corp.; Ross Heater & Mfg. Co.; T. Shriver & Co.; Spencer Turbine Co.; Sprout, Waldron & Co.; F. J. Stokes Machine Co.; Struthers-Wells Corp.; Swenson Evaporator Co.; Taber Pump Co.; Taylor Forge & Pipe Works; U. S. Stoneware Co.; Walworth Co.; Whitlock Mfg. Co.

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(*Editor's Note*—Prof. Bliss's article will be continued in the June issue, with sections on centrifugal and rotary gas pumps and reciprocating compressors; crushing and grinding equipment, including jaw and roll crushers, swing hammer mills and ball mills; and drying equipment.)

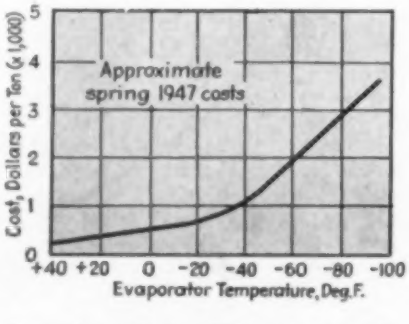
Reprints of this report are available at 50 cents per copy. Address the Editorial Dept., *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

REFRIGERATION COSTS

(*Continued from page 125*)

it will be noted that a sharp change of trend takes place at about −30 deg. F. Of the several reasons for this change at this point, the fact that it is the limit for single stage compression, and that Freon rather than ammonia must be used for lower evaporator temperatures, are most important.

Costs indicated on the curve are based on a complete installation, ready to run, including reciprocating or centrifugal compressor, motor, starter, water cooled condenser and receiver, plus representative low-side equipment such as a water cooler, brine cooler, conditioner, water cooling coils, brine cooling coils or air cooling coils, plus interconnecting refrigerant piping and necessary insulation. If an evaporative condenser is to be used instead of a water-cooled condenser, add $35 per ton capacity. For a cooling tower condensing system the added cost is about $60 per ton as compared with a water cooled condenser, corrected for local conditions. Lumber prices at present exhibit a wide local variation. The $60 factor can be corrected approximately by multiplying by the ratio of 1947 local lumber prices, to local prices on the same lumber in 1945.



Approximate Spring 1947 costs of equipment per ton of refrigerating effect, based on complete plants, with low-side equipment, installed

It is not possible to generalize extensively on the cost of refrigeration equipment except in terms of refrigeration effect required. One generalization however may be of some value. For cold storage holding rooms the following may be taken as approximate current averages:

Capacity, Cu. Ft.	Temperature, Deg. F.	Cents per Cu. Ft. Bldg. Const.	Insulation	Refrig.
>50,000	35	36	30	18
>25,000	0	36	42	30
>25,000	−20	36	54	42

EQUIPMENT COST ESTIMATING, YESTERDAY AND TOMORROW

PAST PERFORMANCE

Past performance on pre-construction cost estimating data for process plants has not been very extensive. Aside from a few data in "The Chemical Engineers' Handbook" and a few articles such as those of Bliss *(Chem. & Met.*, Dec. 1941), Happel, Aries and Borns *(Chem. Eng.*, Oct., Dec. 1946), and Schrader *(Chem. Eng.*, Jan. 1947), neither this magazine nor any other has managed to secure much information of this sort.

HOPES FOR THE FUTURE

With this issue the published data have been considerably amplified, but there are still many gaps, present relative instability of prices adding to the difficulty. This magazine has introduced a new index number series—with trepidation it must be admitted—to aid in keeping cost data up-to-date, for complete plants. Work on improving this index will continue. What else is there for the future?

A considerable number of people are now thinking about the problem. Several articles are already in hand for future issues on various phases of the cost estimating problem, and others are being worked on, among them the following: Vibrating screens; piping costs; heat insulation; industrial instruments; field erected and shop fabricated tanks; welding costs in fabrication; standardization of unit cost data; estimation philosophy for small and medium plants; clad metals; other construction materials; many more equipment cost correlations. Efforts are being directed also toward numerous other subjects.

WHAT YOU CAN DO

The editors will be only too happy to have suggestions. Articles on any phase of equipment cost estimating in the process field will be most welcome. Cost series against capacity are particularly desired, since it has been found that "spot" data are of little use in an effort of this kind. If you have anything to "throw into the pot," let us hear from you.

Solvent Extraction of Vegetable Oils

S. E. TRAY and C. W. BILBE
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

ALLIS-CHALMERS ENGINEERS PASS ALONG SOME OF THE KNOW-HOW THEY'VE PICKED UP DESIGNING PLANTS TO EXTRACT VEGETABLE OILS

Extracting vegetable oils with chemical solvents is a simple laboratory procedure which has been known for a number of years. But transforming this procedure into a commercial plant of several hundred tons capacity requires both engineering and "imagineering." Although the unit processes are not particularly involved, correlating them into a continuous, smooth running, and profit yielding plant offers plenty of opportunity for going wrong. Experience plays no small part in learning where the pitfalls lie and how to avoid them.

AT THE outset, let us examine the flowsheet (pp. 160-163) and review the various unit processes involved in solvent extraction of vegetable oils. It is well to note that these are common to all extraction processes, regardless of design, and differ only as to details of equipment. The first step is the preparation of material, whether it be nuts, beans or presscake, in a manner to break down the cellular structure and expose the oil cells for the action of the solvent. As the flowsheet indicates this includes cracking, steaming, heating and flaking—all designed to make the oil easily accessible to the solvent.

The flaked material then passes to the extractor, where it contacts the solvent, and oil is removed by washing and diffusion. At this point the system is divided into liquid and solid phases, each phase being treated in a different manner. The liquid phase, a mixture of oil and solvent, is clarified by filtration and if necessary by centrifuging before passing to the distillation apparatus. The mixture is first evaporated to remove the major part of the solvent and finally stripped under vacuum to remove the last traces of moisture and solvent. The solvent vapor from evaporator and stripper is condensed and water removed by decantation before returning the solvent to the extractor.

The solid phase, which is the extracted meal, enters dryers where the last traces of solvent are driven off by heat and condensed. In some cases, the solvent-free meal is then conditioned by toasting, followed by cooling, sifting, and sacking in the warehouse. While the flowsheet shown is designed for the extraction of cottonseed oil, the same operations and equipment can be applied to any of the oil-bearing seeds. For those seeds of high oil content, it is often advisable to remove part of the oil by mechanical pressing before extraction. However, each material has different characteristics and decision to prepress should not be reached until all factors have been carefully studied.

Preliminary Considerations

In planning the extraction plant, it is essential to consider a number of factors which influence both the design and operation. Included among these are optimum capacity, supply of material, transportation facilities, power and water supply, and storage space. Plant economics dictate the necessity for continuous operation of a minimum of 300 days per year. New plants, now building, are recognizing this by providing in the design for the processing of more than one kind of material in order to keep in continuous operation throughout the year. Full time operation is especially desirable since trained and competent operating personnel cannot be obtained on a part-time or seasonal basis.

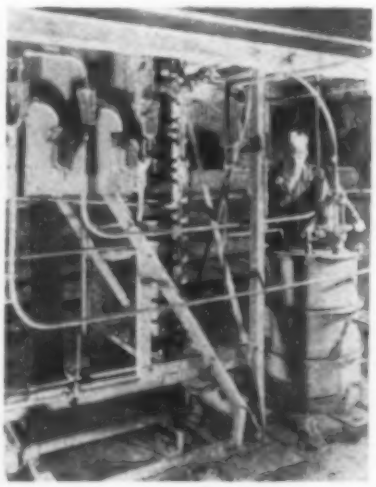
Determining the site of the new plant will be influenced by many local factors and the desirability of utilizing existing facilities, buildings, and equipment. These considerations, which cannot be overlooked, are part of the preliminary engineering which must precede the actual design layout. The owner, of course, will have definite ideas about many of these items, but if he is wise, he will be guided to a large extent by the manufacturer who may also assist in the plant layout.

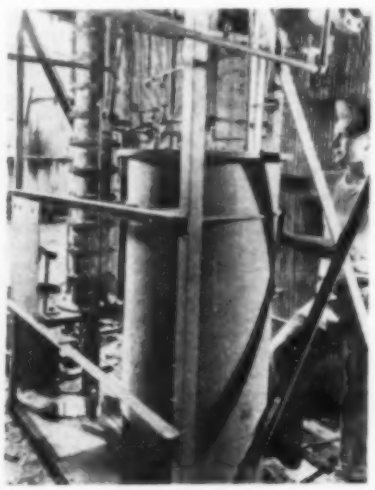
Plant Layout

The physical layout of plant and equipment must be thoroughly considered. Adequate space must be available to permit a distance of 60 ft., and preferably 100 ft., from the solvent

PREACHINGS IN PRACTICE

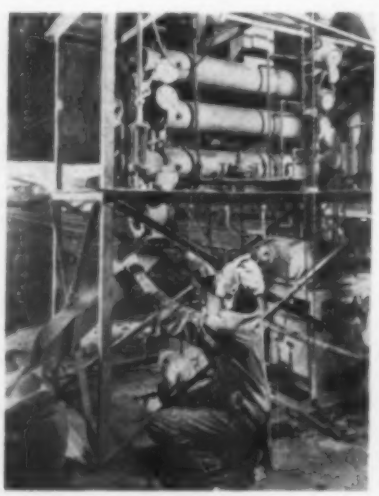
THE PRINCIPLES of design set forth in the accompanying article are no mere ponderings of an armchair engineer. They are the product of much experience and many a plant under the belt. The most recent Allis-Chalmers design, and the one used here as exemplar, is the 200-ton-a-day cottonseed extraction plant just completed for Delta Products Co. at Wilson, Ark. When it began production at the end of March it became the first full scale continuous solvent extraction plant ever built for processing cottonseed. The pictures below show some of the pilot plant equipment set up by A-C inside Delta's older hydraulic-pressing extraction plant. Here the engineering and economic variables of the new, unprecedented application of the solvent process to cottonseed were given a thorough going over before the full-dress installation was attempted. The completed commercial plant is portrayed in the Pictured Flowsheet on pages 160-163. Delta estimates the new plant will return 45 extra lb. of oil per ton of seed, as compared with recovery by hydraulic pressing. At the prices for oil and meal prevailing in February, the net addition to profit should come close to $11 per ton. Part of the gravy derives from labor savings. Only two men per shift are required to operate the solvent extraction equipment. (There were eight to ten men in the hydraulic press room). Also agreeable is the quality of the product. Refineries report the oil acceptable in every way for manufacture into hydrogenated shortenings and similar products.

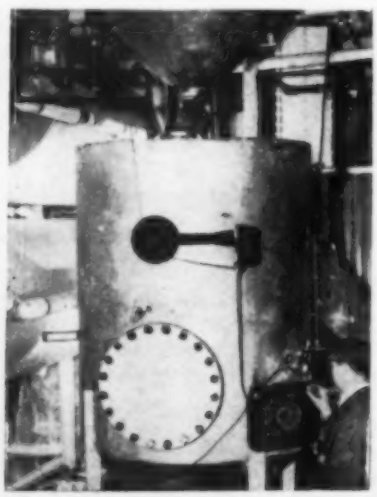




Four views of pilot plant. Above: Controls, extractor, meal discharge conveyor, miscella tank. Below: Dryers

Above: Stripping column, miscella filtrate tank. Below: Collector tank connected to bottom of vapor scrubber





building to other structures, railroads, or public roadways. Within the plant the equipment should be easily accessible both for operating and maintenance. Ample room should be provided around the dryers, tanks, and distillation equipment to permit clear visibility and to allow the removal of internal parts, if necessary, for cleaning and inspection. Usually one lives with a plant for many years, and a little time and thought devoted to arranging equipment for ease of operation and maintenance will pay handsome dividends. It has been suggested that the ideal plant would have no spouts and no conveyors. This ideal should be approached as closely as possible since experience indicates that 60 percent of production stoppages in extraction plants can be traced to failure of materials transport equipment. Time spent in arrangement studies, resulting in fewer and shorter conveyors and elevators, is well worth while.

Choosing a Solvent

In considering the type of solvent to be used, a non-flammable solvent has immediate appeal from a safety angle and has received much attention. There are a number of disadvantages, however, which appear only on further study of the solvents available. Based on equal volumetric losses, the use of non-flammable trichlorethylene as compared to flammable hexane would, for example, add more than $2 per ton to the cost of processing oil-bearing meal. Also, trichlorethylene is not sufficiently selective and may result in a dark crude which brings higher refining costs. In addition, the chlorinated solvents are more toxic than the simple hydrocarbons, and in the absence of complete stabilization they may break down into difficult, corrosive, and even dangerous compounds. Other flammable solvents such as alcohol and toluene have been investigated, and, depending on the material to be processed, offer certain advantages in individual cases. At present, however, most commercial plants use hexane, chiefly because of the lower cost of operation.

If flammable solvents are used, the idea of building the extraction equipment outdoors appears attractive as a means of reducing fire hazards. This, of course, is common enough in the petroleum industry where liquids and vapors only are handled. In a vegetable oil solvent plant, however, solids handling is also involved, generally in a hot, moist atmosphere, and these solids do no readily lend themselves to automatic control as do most liquids and vapors. From an operating and

maintenance viewpoint it usually seems desirable to house the equipment containing the solid phases, especially in northern climates.

An accompanying sketch shows a suggested layout for a southern solvent extraction plant with all of the extraction equipment located out of doors. Preparation equipment is housed in the large building at the right, while filters and the control room are housed in the two small buildings in the foreground. In such an installation the saving in building costs is partially offset by the cost of supporting steel and platforms, in addition to increased cost of thermal protection required. An outdoor plant requires heavier weatherproof insulation, and much equipment which would not require covering inside must be insulated outside to avoid damage by atmospheric moisture.

The Buildings

If buildings are used they should have large window area, provided in sash hinged at the top, and they should be ventilated by monitors in conjunction with fans just above the floor line at the lower level. These fans should be designed to pull air in, rather than to blow it out, since the natural stack action of the building aided by these fans will rapidly reduce by dilution any vapor concentration that may result from leakage or accidental spillage. Since hexane vapor is about three times as heavy as air, the building should have no basement or pockets where heavy vapors might accumulate.

Concrete or concrete-and-brick construction is, of course, very satisfactory, but the most expensive. A steel structure with Transite or similar siding has proved adequate in a number of cases. This type of construction in a cottonseed extraction plant is illustrated in the second sketch. Steel members of the building should be electrically bonded together by copper straps or by welding, and in addition, all electrical equipment should be grounded in accordance with the National Electrical Code.

Fire

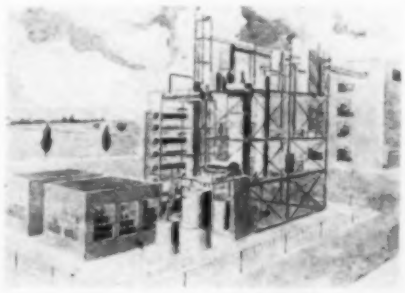
For fire protection, the so-called "fog system" with a separate water supply and standby power source appears to be the best combination. Conventional sprinkler systems and steam "snuffer" systems have also been used. Carbon dioxide systems are attractive from a theoretical viewpoint but are expensive and have some practical limitations. Outdoor installations do not entirely eliminate the need for fire protection, as most insurance companies recommend that deluge systems be installed on all principal equipment, regardless of location.

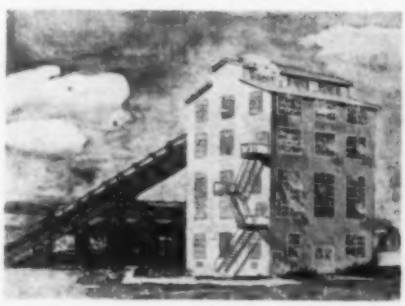
From an operating viewpoint there is little difference whether the extraction plant is adjacent to the preparation building, separated only by a fire wall, or placed some distance away. In the first arrangement there is no interior door communication between the two parts of the building. Thus the preparation and extraction units operate entirely apart, each having its own operating crew. It is necessary, of course, to provide for easy communication between the two units, since proper results depend largely on uniform movement of material through the plant. The mill through-put rate is established by the preparation room, but the extraction room must be constantly advised of any preparation changes which might influence extraction operation.

Piping

The layout of piping in a solvent plant should be made with the view of keeping runs as short as possible and still serving a functional purpose. Of special importance is the proper pitch of drain lines and vapor lines to avoid pockets. To this end, it is advisable to detail the larger inter-connecting piping and to supply a detailed piping diagram for the contractor, giving sizes and pitches of the smaller piping. Piping generally is welded, with sufficient flanges and unions to permit access to equipment for cleaning and inspection. All condensate drains should be properly trapped with by-passes arranged for trap maintenance. Lines carrying unfiltered miscella (oil-solvent mixture from extractor) should be provided with clean-out plugs at tees and elbows to permit easy removal of any settled material. Ease of operation should not be overlooked in locating valves and controls, and pump locations providing for easy accessibility make for a smooth-running plant.

Outdoor and indoor extraction plants





Automatic Control

Control should be automatic wherever feasible and should be centered in a master panel for easy visibility. Since much of the process involves flow of fluids and the maintenance of constant pressures and temperatures, these lend themselves to precise and automatic regulation with ordinary controlling instruments. In some instances, recording instruments serve a useful purpose in maintaining a record of operating conditions which is helpful in studying plant performance. As in any continuous process, remote control equipment can often be applied to advantage, but one should not lose sight of the fact that the personal attention of the operator is advantageous at certain key points in the process. Good engineering dictates that automatic control can be applied at most of the control points in the process but cannot substitute for an operator's judgment and continuous vigilance.

Complete wiring diagrams should be worked out along with the plant layout. Push-button stations complete with pilot lights for all equipment should be grouped in accordance with operating sequence. The starters themselves can be located in a non-hazardous area, well protected from dust and dirt, thus eliminating the need for explosion-proof equipment. Because of the continuous nature of the process, all principal equipment, especially in the extraction building, should be electrically interlocked. Thus it is necessary to start the plant in proper sequence and interruptions to any unit will shut down equipment ahead of it. Interlocking with preparation equipment is probably not advisable, but where interlocks are broken, surge capacity or spill-overs should be provided. Overload protection on all motors by means of thermal relays is desirable, and permanently installed indicating ammeters on all apparatus handling solids will afford a means of detecting overloading before a shutdown occurs.

The extraction plant itself represents only a part of the total installation cost

(Continued on page 153)

To award... CHEMICAL ENGINEERING

Announcing Plans for the Eighth in the Biennial Series of Awards to be Presented in the Process Industries Next December

COMMITTEE OF AWARD FOR *Chemical Engineering Achievement*

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WALTER G. WHITMAN, Massachusetts Institute of Technology, Cambridge, Mass.
GEORGE GRANGER BROWN, University of Michigan, Ann Arbor, Mich.
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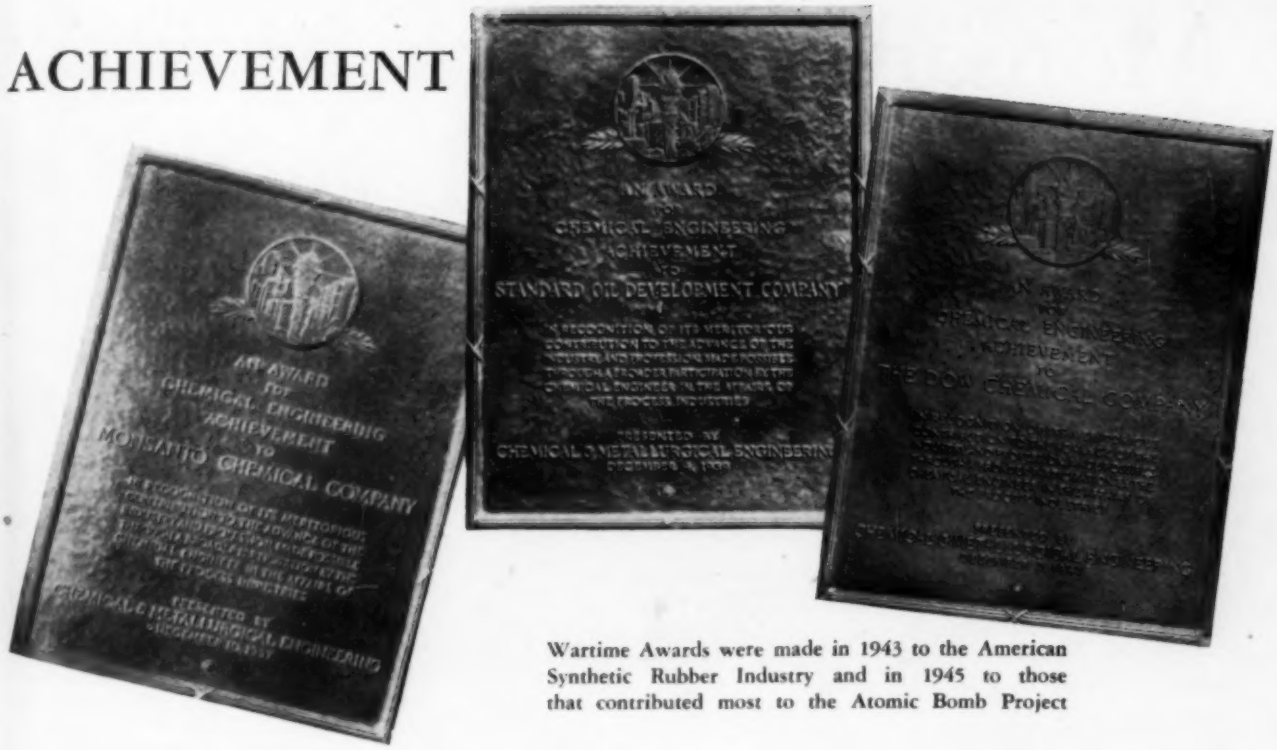
KENNETH A. KOBE, University of Texas, Austin, Tex.
J. D. LINDSAY A & M College of Texas, College Station, Texas
ROBERT M. HUBBARD, University of Virginia, Charlottesville, Va.
FRANK C. VILBRANDT, Virginia Polytechnic Institute, Blacksburg, Va.
HENRY K. BENSON, University of Washington, Seattle, Wash.
OLAF A. HOUGEN, University of Wisconsin, Madison, Wis.
ERNEST D. WILSON, Worcester Polytechnic Institute, Worcester, Mass.
BARNETT F. DODGE, Yale University, New Haven, Conn.

FOURTEEN YEARS ago this month we announced plans for a unique award for chemical engineering achievement. In contrast with most medals and similar citations, this award was given to a company rather than to an individual because its primary purpose was to recognize group effort—particularly the sort of achivements that result from teamwork between technology and management in a corporate organization. It also served to focus public attention on those progressive companies that have encouraged their chemical engineers to participate broadly in all the affairs of the process industries.

The first of these awards was in 1933 to the Carbide & Carbon Chemicals Corp.; the second two years later to the Organic Chemicals Department of E. I. du Pont de Nemours & Co. In 1937 the award went to the Monsanto Chemical Co., and in 1939 to the Standard Oil Development Co. The fifth of these awards was made to the Dow Chemical Co. on Dec. 2, 1941—five days before Pearl Harbor.

During the four fateful years that followed all industrial resources were pooled in the greatest group effort of history. It was most appropriate, therefore, that in 1943 the Committe should vote unanimously to present the sixth award to the entire American synthetic rubber industry—thus recognizing those chemical, rubber and petroleum companies that carried the major responsibility for this great wartime

ACHIEVEMENT



Wartime Awards were made in 1943 to the American Synthetic Rubber Industry and in 1945 to those that contributed most to the Atomic Bomb Project

achievement. Confronted with an equally difficult decision in 1945, the Committee again voted unanimously to accord this recognition to the Atomic Bomb Project—to more than a hundred companies, universities and research organizations that contributed most significantly to the success of that tremendous undertaking.

Now with the war behind us, industry is again on its own. Most of the barriers and restrictions have been removed from individual enterprise and it seems only fitting and proper that this year the Award for Chemical Engineering Achievement should return to its original purpose of recognizing group effort within a single company rather than in an entire industry or group of industries. Accordingly, the following rules and regulations have been agreed upon by the Committee of Award. The members of the committee will welcome comments, criticisms and suggestions from all readers of *Chemical Engineering*. We want to make this eighth award another great milestone in the continuing advance of our profession.

S. D. KIRKPATRICK, *Secretary*

Rules and Conditions Governing the Eighth Award
FOR CHEMICAL ENGINEERING ACHIEVEMENT

1. The purpose of this Award is to encourage a broader participation of the chemical engineer in the affairs of the process industries by giving public recognition to that company which through coordinated group effort has contributed most to the advance of the industry and profession. This eighth award will apply only to industrial developments that have come into commercial fruition or become publicly known since August, 1945.
2. The award will consist of an appropriate bronze plaque suitably engraved to indicate the nature of the achievement and the name of the company to which it is presented. The award will be made at a dinner of the chemical engineering profession to be held in the Waldorf-Astoria Hotel in New York City during the next biennial Exposition of the Chemical Industries in the week beginning Dec. 1, 1947.
3. The award is to be made to a company rather than to any individual within a company, since it is primarily a recognition of group effort. However, any subsidiary or department within a corporate organization might be eligible for the award on the basis of special achievements brought to the attention of the Committee of Award.
4. The Committee of Award shall consist of the heads of chemical engineering in all of the educational institutions of the United States whose courses as of May 1, 1947, have been accredited by the American Institute of Chemical Engineers and the Engineers Council for Professional Development. Dr. Alfred H. White, Professor Emeritus of Chemical Engineering at the University of Michigan, and member of the Award Committee since its inception in 1933, will continue to serve as chairman. The editor of *Chemical Engineering* will serve as secretary but without vote.
5. It is the function of the committee to review the achievements of the various companies, to receive suggestions from all sources, and to determine which company has, in its judgment, contributed most to the chemical engineering profession during the interval under consideration.
6. Any company in the process industries desiring to be considered for this award is urged to submit, in confidence, the following information:
   (a) What is the nature of the achievement?
   (b) During what period has it come into commercial fruition?
   (c) To what extent have chemical engineers participated in its development?
   (d) Are there any supplementary records, data, articles or references which should be included as pertinent to a fair consideration of this achievement and of the company's attitude toward its chemical engineers?
7. This Award is not restricted to those companies which file formal applications with the committee. Suggestions are desired from any and all sources that will assist the committee in directing attention to industrial groups that should have its consideration. Communications should be addressed to S. D. Kirkpatrick, Secretary, Committee of Award, Room 2400, 330 W. 42nd St., New York 18, N. Y.

Monsanto Suffers Most In Texas City Tragedy

J. V. HIGHTOWER

Southwestern Editor, *Chemical Engineering*, Houston, Tex.

ON-THE-SCENE REPORT OF ONE OF CHEMICAL INDUSTRY'S WORST DISASTERS SHOWS TREMENDOUS LOSSES IN LIFE AND PROPERTY

VICTIM OF one of the worst disasters in the history of American chemical industries, the styrene manufacturing plant of the Monsanto Chemical Co. at Texas City is reported by Monsanto officials as virtually a complete loss following fires in the chain reaction of destruction touched off by the explosion, on April 16, of an ammonium-nitrate laden French freighter, Grandcamp, in a slip several hundred feet from the plant. Explosion, early the next day, of a second nitrate ship nearby accelerated the destruction of Monsanto's flaming plant.

An ironic twist of the disaster, which claimed hundreds of lives and destroyed more than a hundred million dollars of property, is that Monsanto was not manufacturing the nitrate which had been loaded by the freighters. Its plant, the farthest point of which was not more than 900 ft. from the exploding ships, was manufacturing styrene and polystyrene for plastics.

In Texas City, one week after the tragedy, bandaged and limping plant officials of the Monsanto plant said that little of the facilities can be reclaimed. Fronting the North Slip, where the first explosion occurred about 9:30 a.m. on April 16, the new polystyrene plant, just completed at an estimated cost of $1,000,000 to produce about 80 million pounds of plastic material per year, has been ruined.

Also near the North Slip was the cracking unit where propane was converted into ethylene, one of the raw materials for styrene manufacture. Preliminary inspections indicated that some small part of the equipment may be salvaged.

Little hope is held for the gas-separation plant, consisting principally of compressors and fractionators. Plant engineers believe that most of this equipment is beyond recovery.

How far the sweeping flames had ruined the catalytic dehydrogenation plant, where ethyl benezene was converted to styrene, was still undetermined late in April. This plant was outside of the most violent blasts.

Little hope was held that the fractionators used for final purification of styrene could be reclaimed without major alterations. Monsanto plant engineers, still suffering from shell shock, told me in Texas City, while trying to prepare their report to St. Louis, that inspection would be needed to determine whether the fractionators were out of plumb and would require reconstruction.

The blasts ruined the electrical instruments in the Monsanto plant. The electrical system, including motors and most of the overhead piping, was badly damaged. Some of this piping probably can be salvaged. Late in April, surveys were being made to determine the extent of the damage to underground piping and wiring.

Under the terrific blasts from the docks, buildings in the Monsanto plant were reduced to a shambles. The laboratory, a brick and steel structure, was destroyed. Likewise ruined was the office building, another brick and steel structure. The Monsanto service building was blown down. Though some structural steel may be saved, the laboratory is a complete loss.

As to the future, President William M. Rand, of Monsanto, last month said that under present plans, a new plant would be built at Texas City on the same site with the same capacity for styrene production. Plant engineers are already rushing plans for reconstruction of the flame-blasted area.

Monsanto bought the styrene plant at Texas City from War Assets Corp. last August for $9.5 million. Designed and built by Monsanto, it was the first such plant to be put into operation in the government's wartime rubber program. Original cost of the plant was $20 million. The plant was supplying about one-fourth of the styrene needed in the manufacture of synthetic rubber.

A few weeks prior to the disaster, Monsanto had put into operation its million-dollar polystyrene plant for the manufacture of polystyrene plastics. The manufacturing building was a four-story structure of steel and concrete. Storage for the plastic was a similar building of two stories. Both of these, fronting on the North Slip, where occurred the ruinous first explosion, were destroyed. The polystyrene plant has to be rebuilt.

The fearful loss of life at Texas City, Monsanto Chemical Co. officials say, far outweighs the company's material losses there. Monsanto's dead was expected to reach 170, and this does not include losses of the W. S. Bellows Construction Co., which had men working on the polystyrene plant and other structures. Of 64 Bellows men in the plant, 10 were known dead and 21 were unaccounted for. Bellows had two subcontractors, of whose men at least twelve were killed or missing in the disaster.

As evident from the photographs Monsanto suffered most from this destruction. Great damage was done, however, to oil storage and refining facilities in the immediate vicinity. Carbide & Carbon Chemicals Corp. and the refineries of Pan American Refining Co. and Republic Oil Refining Co., which were farthest from the blast, reported damage but no loss of life.

This pre-disaster aerial view of Texas City, shows location of major areas involved in the city's series of explosions and fires. Fire aboard the nitrate-loaded French ship and the American vessel on April 16 resulted in an explosion which spread to Monsanto Chemical Co. plant to the north

Associated Press photo

Long building at right housed polystyrene unit completed two months ago at cost of a million dollars. White building was the office

Associated Press photo

After explosions and fires destroyed the plant. Remains of styrene units which had been built at a cost of 20 million dollars. Raw materials, benzene, propane, and ethylene as well as the styrene itself, burst into blinding flames as tanks and piping were ruptured by heat and flying steel which fired the entire plant

Associated Press photo

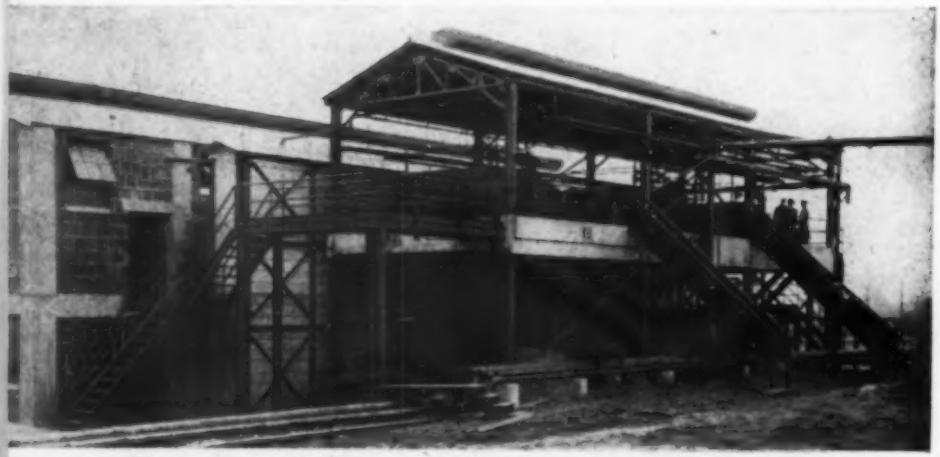
Monsanto's Texas City plant before tragedy showing slip at right where ships were loading nitrate, polystrene unit in center, and styrene units at rear

Elwood Payne photo

THE PRODUCT THAT COULDN'T EXPLODE

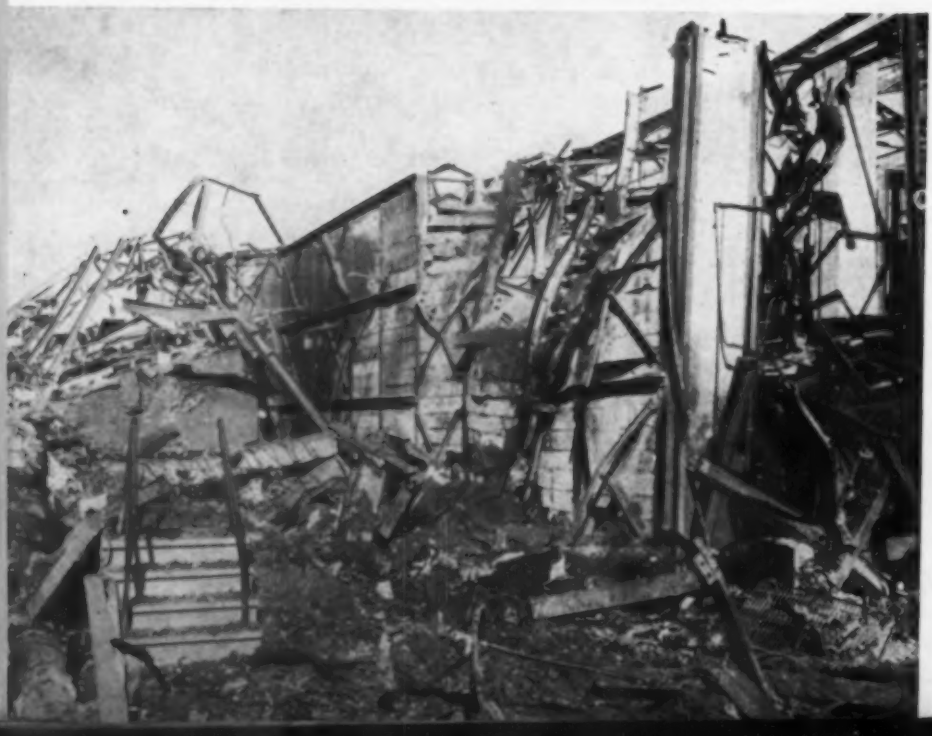
CROSBY FIELD
Colonel, Ordnance Department Reserves, USA

WARTIME EXPLOSION OF AMMONIUM NITRATE EVAPORATOR TRACED TO OIL CONTAMINATION OF COMPRESSED AIR USED FOR AGITATION



Standard "high pan" evaporator ammonium nitrate plant before explosion

Below: same nitrate plant after 4,800 lb. of ammonium nitrate exploded



AMMONIUM NITRATE as an explosive first came into large quantity production during World War I as the "ama" part of amatol, the well-known high explosive. This mixture of ammonium nitrate and TNT was evolved to conserve the wholly inadequate supply of TNT then in the hands of the Allies. Two mixtures were in general use: "50-50," that is, 50 percent ammonium nitrate and 50 percent TNT, and "80-20," 80 percent ammonium nitrate and 20 percent TNT. In those early days, the great problem was to produce ammonium nitrate, the behavior of which in the amatol mixture could be properly pre-determined and would remain uniform. Different processes gave different types of ammonium nitrate and, although chemically the changes were minor, the effect on characteristics, particularly sensitivity, was very great.

Despite these difficulties, which were accentuated when the still decreasing adequacy of TNT supply made it highly desirable to reduce the TNT content in amatol to as near zero as possible, little attention was paid to the dangers inherent in the nitrate itself. It was not until the catastrophe at the government-owned T. A. Gillespie shell and bomb loading plant at Morgan (near South Amboy, N. J.) in October 1918 demonstrated the devastating effect of an explosion of bulk ammonium nitrate that we began to remove from our minds the thought that nitrate was "inert." We moved it over into the class of "dangerous" if not "explosive" materials.

At the Gillespie loading plant there

By curious coincidence, this fourth article in Colonel Field's series of investigations of accidental explosions in munition plants of World War II deals with ammonium nitrate—the product that started off the terrible tragedy at Texas City last month. At our urgent request the author, who served as deputy director of safety for all the Ordnance Department's explosive and munition plants during the late war, has supplemented his original account of this particular wartime explosion to include pertinent data on the behavior of ammonium nitrate under various conditions.

were large piles of ammonium nitrate in bulk as well as in wooden barrels which detonated en masse, leaving huge, deep craters. One supposition was that the intense heat of the conflagration nearby and the burning of the containers themselves caused a film of sensitive molten ammonium nitrate to form and this was set off by the impact of a shell catapulted into the mass from a nearby magazine explosion. Presumably that in turn set off the pile of ammonium nitrate, but regardless of the cause, we know that ammonium nitrate at Morgan did explode and did cause severe damage.

Hardly had we recovered from this shock when the catastrophe at Oppau occurred on Sept. 21, 1921. Then followed the disastrous explosion at Nixon, N. J., on March 1, 1924—all of which led to exhaustive investigations by the United States Bureau of Mines, the National Research Council and the Ordnance Department.

Because the Ordnance Department was alert to the dangers connected with ammonium nitrate, the huge ammunition program of World War II was successfully carried out with only one not-too-serious high-pan explosion in which four men were killed and seventeen injured. The purpose of this article is to describe our investigations of that explosion.

Following Standard Practice

Evaporation of ammonium nitrate to dryness by means of steam heated pans has long been standard practice in the American chemical industry. The introduction of air for agitation by means of pipes or "lances" as they are called has also been customary.

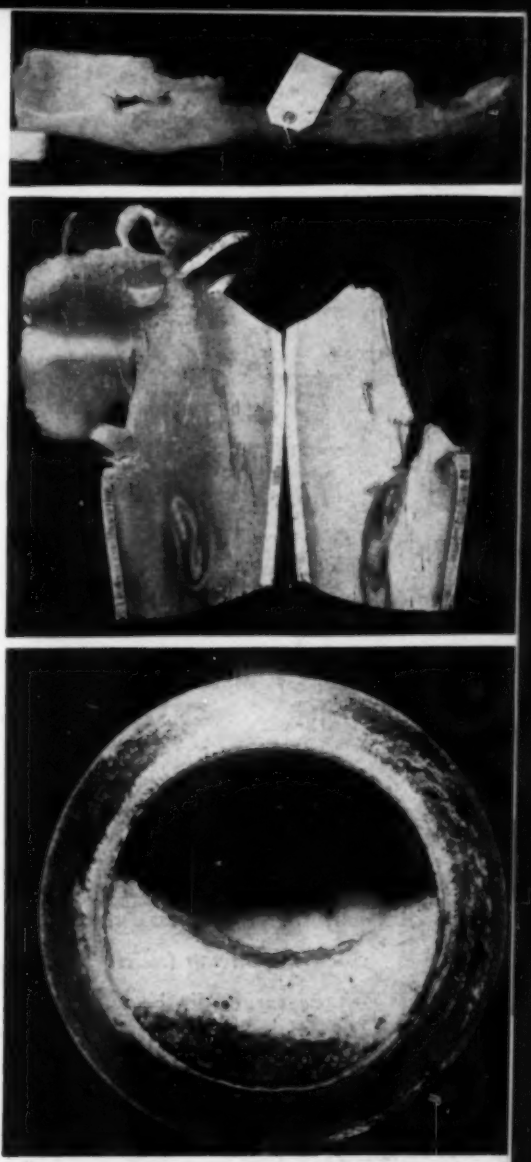
Everybody connected with the industry was greatly surprised, therefore, when this plant suddenly exploded. An investigation making use of a missile map was made. In this particular case, however, the discovery of a single missile and its intensive study provided the necessary information.

This particular missile, a piece of agitator pipe, invited attention because it was the only piece of lance found that had been blown outwardly, that is, destroyed by internal explosion. All other pieces recovered had been collapsed by external forces. Because of this difference this missile was selected for concentrated further study.

This piece of pipe was taken, cut open and investigated carefully. This included chemical and physical analyses of the missile. The marks of a deflagration leading into a pair of air holes and burning the interior wall of the pipe along a line just above the level of the molten contaminated ammonium nitrate showed plainly the cause of the explosion. An ordinary oil-air explosive mixture was forced upon the molten ammonium nitrate which was at a temperature somewhere between 306 deg. and 309 deg. F. (its "fudge point"). The resulting deflagration of the air and oil set off the previously oil-contaminated molten nitrate which in turn exploded, bursting the lance and setting off the main 4,800-lb. charge in the pan.

The facts concerning the air-oil mixture were found by examining very carefully the operation in an identical plant. Ample oil was put into the high-pressure line by the compressor to give an explosive air-oil mixture. Although there were ceramic filters in the line it was found that sufficient oil passed through them to keep the oil-air mixture in the explosive range. Oil content, varying from 0.11 percent to 0.25 percent, was found in the nitrate taken from the inside of an air agitator or lance removed from the pan adjoining the one which exploded. The nitrate found along with this contamination was set up solidly and was not a mere sedimentation of crystal. In as much as this lance had been through the explosion, the original amount of oil in the content may have been much in excess of the above figures.

Check tests from the Bureau of Mines, other data, and literature indicate that chemically pure ammonium nitrate may be heated up to the decomposition point (above 400 deg. F.) and decomposed without either deflagration or explosion. The admixture of very small amounts of carbonaceous materials renders the mixture sensitive at high temperatures in its molten state. In addition there is a suspicion that a slight amount of zinc from the galvanized pipe may have been present and this type of material is known to act as a catalyst. As a result of this explosion the use of all types of air compressors requiring the introduction of oil into the air stream have been abandoned in ammonium nitrate manufacture.



Top: Only agitator pipe destroyed by internal explosion

Center: This pipe cut open shows marks of a deflagration leading to a pair of air holes and burning interior wall of pipe along line just above level of molten contaminated nitrate and plainly shows cause of explosion

Bottom: Cross section of pipe with contaminated nitrate

Combustion Calculations For Hydrocarbon Fuels

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A SIMPLIFIED SYSTEM BASED ON THE CARBON-HYDROGEN RATIO AND CARRIED OUT LARGELY BY NOMOGRAPHS. SECOND OF TWO PARTS

Here is the second half of an article begun in the April issue. It greatly simplifies combustion calculations for hydrocarbon fuels, particularly liquid petroleum fuels. The system, which is distinguished by its use of the carbon-hydrogen ratio as a basis, has three main advantages. It uses nomographs to perform computations. It is applicable to a wide variety of hydrocarbon fuels. Its inherent errors are small.

FROM the basic correlations presented so far, a correlation between the C/H ratio of the fuel, the flue gas temperature, the percentage of carbon dioxide in the dry flue gas, and stack losses, can be developed.

Stack Losses

This correlation is based on the following assumptions: (1) Fuel is 100 percent hydrocarbon. (2) Air supply and fuel are dry and at 60 deg. F. (3) Fuel is completely converted to carbon dioxide and water vapor. (4) Carbon dioxide and water vapor do not dissociate.

Assumption (1), namely that the fuel is 100 percent hydrocarbon, will introduce little error for most distillate fuel oils. For residual fuels, heat losses calculated on the basis of this assumption will be 1 to 2 percent too high due to non-hydrocarbon impurities.

Correction of stack losses based on fuel and dry air at 60 deg. F.—assumption (2)—for higher fuel and air temperatures and humidity is relatively simple. The heat content above 60 deg. F. of one pound of fuel, and the air supply (including humidity) per pound of fuel, must be subtracted from the stack loss; and the sensible heat content of the water vapor in the air at stack temperature must be added to the stack loss. This operation is simplified by the nomographs of Figs. 2, 3 and 5. (Figs. 1-3, Equations 1-18, and Tables I and II were published in the April issue.) Heat contents of air and water vapors based on spectroscopic data are the basis of Fig. 5.

Assumption (3), i.e., complete combustion of the hydrocarbon fuel, is justified for most oil and hydrocarbon-gas burners. Dissociation reaches an order of magnitude that will affect combustion calculations at 3,000 deg. F. and no excess air. With 20 percent excess air or more, errors due to dissociation up to stack temperatures of 3,500 deg. F. should be well within the limits of accuracy of the correlation (assumption 4).

The stack loss correlation above 60 deg. F., for dry air and water as a liquid, is based on equations 10a, 11a, 12, 13, 14, 15, 16 and 18, with the latent heat of vaporization of the water vapor formed during combustion included in the minimum stack loss. It is convenient to divide the calculation of total stack loss (L) into minimum stack loss ($L_{min.}$) and stack loss due to excess air (L_a).

$$L = L_{min.} + L_a \qquad (19)$$

where

$L_{min.}$ = (Eq. 10a) (Eq. 14)+(Eq. 11a) (0.791) (Eq. 16)+[Eq. 15] [(Eq. 12)+(1,058) (18.02)]

and

L_a = (Eq. 16) (Eq. 18) (Eq. 13)

Simplifying:

$$L_{min.} = T^{1.34}[(1.655+0.474R)/(R+1)] + [(5{,}900-1{,}043R)/(R+1)] \qquad (20)$$

$$L_a = [2.060T^{1.34}-2{,}850][R-4.785PR-11.35P]/[12P(R+1)] \qquad (21)$$

The maximum error of Equation (19) for a flue temperature range from

Table III—Maximum Flame Temperature (Comparison of Values Obtained From Different Sources)

Fuel Gas	$Q_{p,s.s}$ B.t.u. per Lb.	C/H Ratio	Maximum Flame Temperature, Deg. F. Fig. 6	Fig. 6, Corrected*	Calculated*	Observed*
Methane	23,900	3.98	3,550	3,495	3,484	3,407
Ethane	22,300	3.97	3,605	3,550	3,540	3,443
n-Propane	21,700	4.47	3,625	3,575	3,573	3,497
n-Butane	21,300	4.77	3,625	3,575	3,575	3,443
Ethylene	21,650	5.96	3,810	3,760	3,762	3,787
Propylene	21,050	5.96	3,740	3,695	3,722	3,518
Butylene	20,700	5.96	3,700	3,655	3,691	3,506

* Fig. 6 corrected for humidity by Fig. 5.

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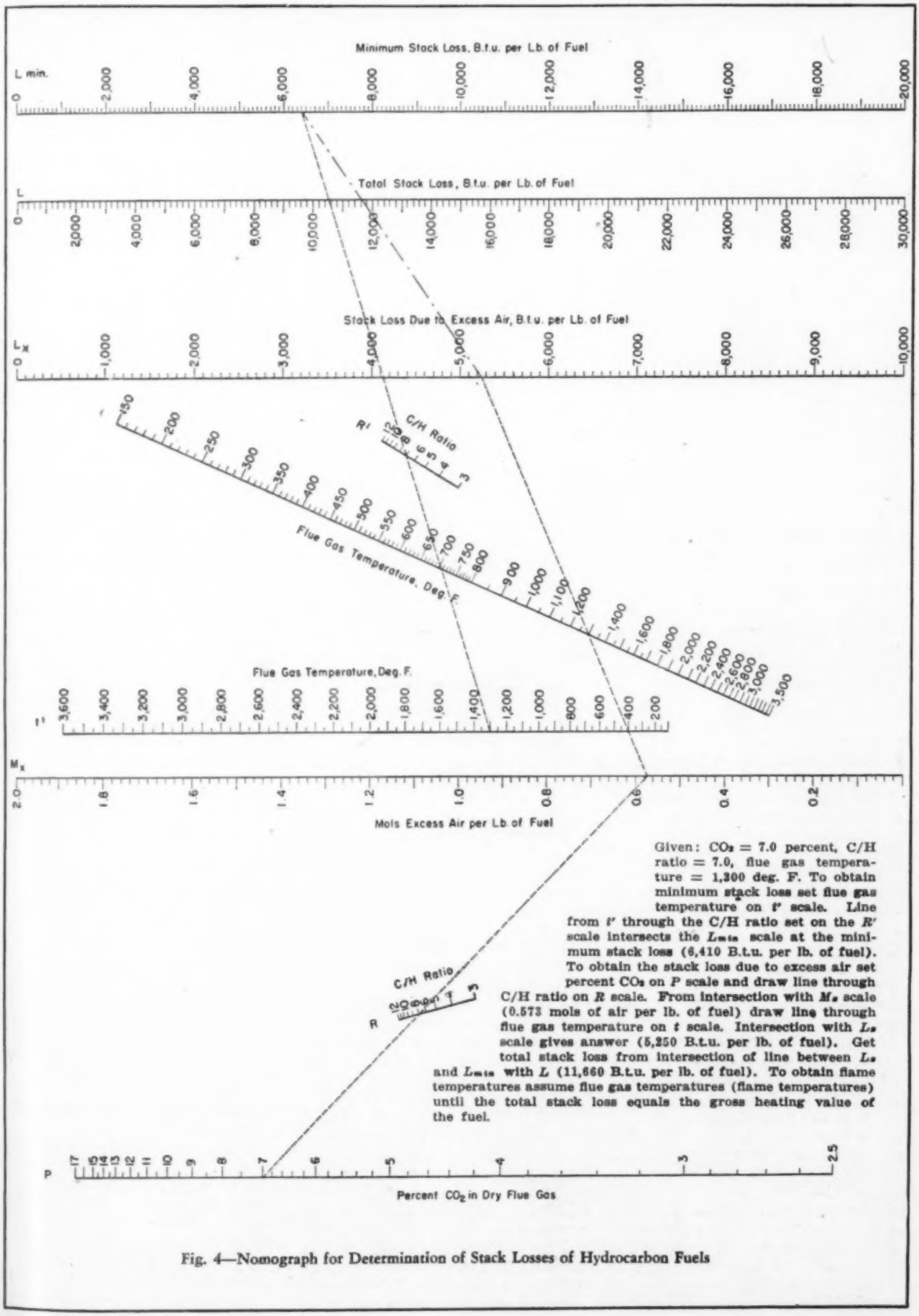

Given: CO_2 = 7.0 percent, C/H ratio = 7.0, flue gas temperature = 1,300 deg. F. To obtain minimum stack loss set flue gas temperature on *t'* scale. Line from *t'* through the C/H ratio set on the *R'* scale intersects the L_{min} scale at the minimum stack loss (6,410 B.t.u. per lb. of fuel). To obtain the stack loss due to excess air set percent CO_2 on *P* scale and draw line through C/H ratio on *R* scale. From intersection with M_x scale (0.573 mols of air per lb. of fuel) draw line through flue gas temperature on *t* scale. Intersection with L_x scale gives answer (5,250 B.t.u. per lb. of fuel). Get total stack loss from intersection of line between L_x and L_{min} with *L* (11,660 B.t.u. per lb. of fuel). To obtain flame temperatures assume flue gas temperatures (flame temperatures) until the total stack loss equals the gross heating value of the fuel.

Fig. 4—Nomograph for Determination of Stack Losses of Hydrocarbon Fuels

250 to 3,500 deg. F. is 2 percent. This value is based on the basic assumptions given above. For a large part of the normal operating range (500 to 2,000 deg. F. stack temperature) the error will be much lower, usually in the range of 1 percent. The additional error due to inaccuracies of the C/H ratio value will be negligible if the method of Fig. 1 and Equation 1a or 1b is applicable, but for an error of 5 percent in the C/H ratio the corresponding deviation of $L_{min.}$ is 1.9 percent at 1,000 deg. F. and 2.7 percent at 2,000 deg. F. in the 7 C/H ratio range. The deviation of L_s will be in the same order of magnitude. Equations 20 and 21 are presented in nomographic form in Fig. 4 and their correction for air and fuel temperatures above 60 deg. F. and with varying humidities can be accomplished easily by the use of Figs. 2, 3 and 5 as discussed above.

Dissociation Losses With Theoretical Air Requirements

In the calculation of flame temperatures, the heat losses due to dissociation of carbon dioxide and water vapor are an important factor. In order to correlate these losses with the C/H ratio and the flame temperature, it is assumed that the fuel is 100 percent hydrocarbon and burned with dry air. The equilibria considered are:

$$2\,CO_2 = 2\,CO + O_2$$
$$2\,H_2O = 2H_2 + O_2$$

and are assumed to be independent of each other.

For the extent of dissociation of carbon dioxide and water vapor, data by H. Zeise[31, 32] and Lewis and Von Elbe[33] were used. The thermodynamic functions used as a basis for the calculation of the equilibrium constants by the three investigators were compared with those used for the most recent calculations for the lower temperature range by Wagman et al.[37] Insufficient deviation to warrant recalculation for the 3,000 to 4,500 deg. R. temperature range was found. The equations for the fraction dissociated (x) for a partial pressure of 0.130 atmospheres are:

$$x]_{H_2O} = (1.558)\,(10^{-23})\,(T^{9.455}) - 0.00120 \quad (22)$$
Max. error 3,100 to 4,500 deg. R. = 1.2 percent

$$x]_{CO_2} = (4.63)\,(10^{-23})\,(T^{9.455}) - 0.0051 \quad (23)$$
Max. error 3,100 to 4,500 deg. R. = 3.7 percent

The variations of partial pressure at 1 atm. total pressure for variations of C/H ratio from 3 to 12 are 0.0946 to 0.1605 atm. for CO_2 and 0.1893 to 0.0803 atm. for H_2O at theoretical air supply. The variation of dissociation within this range of partial pressures may be expressed in the form:

Carbon Dioxide:
$$x_p = [x]_{0.13\ atm.}\,[0.358 + 0.730 \log (1/p)] \quad (24)$$
Max. error 0.09 to 0.17 atm. = 1.3 percent

Water Vapor:
$$x_p = [x]_{0.13\ atm.}\,[0.333 + 0.758 \log (1/p)] \quad (25)$$
Max. error 0.08 to 0.20 atm. = 0.6 percent

It can also be shown that the partial pressures of CO_2 and H_2O in the flue gas are a direct function of the C/H ratio when the fuel is burned with exact theoretical air requirements:

Water Vapor:
$$p = 6/(4.783R + 17.35) \quad (26)$$

Carbon Dioxide:
$$p = R/(4.783R + 17.35) \quad (27)$$

The heat of dissociation at 4,500 deg. R. was calculated from Rossini's values at 25 deg. C.[34, 37] and the heat content values of carbon dioxide, carbon monoxide, water vapor, hydrogen, and oxygen given by Heck.[9] In order to compensate as well as possible for variations of the heat of dissociation over the 3,100 to 4,500 deg. R. temperature range without introduction of additional powers of T, the constants in Equations (22) and (23) were adjusted. The complete equations valid for C/H ratios of 3 to 12 and temperatures from 3,100 to 4,500 deg. R. are:

Water Vapor:
$$L_d = 108{,}970\,[1/2(R+1)]\,[1.558\,T^{9.455} 10^{-23} - 0.00122]\,[0.333 + 0.758 \log \frac{4.783R + 17.35}{6}] \quad (28)$$
Max. error 2.3 percent

Carbon Dioxide:
$$L_d = 118{,}250\,[R/12(R+1)]\,[4.63\,T^{9.455} 10^{-23} - 0.0050]\,[0.358 + 0.730 \log \frac{4.783R + 17.35}{R}] \quad (29)$$
Max. error 4.0 percent

Equations (28) and (29) were obtained from Equations (14), (15), (22), (23), (24), (25), (26), (27) and the other factors discussed above.

Flame Temperatures

It will be shown that calculated maximum flame temperatures are a function of the heating value and the C/H ratio of the fuel under the assumption that maximum flame temperatures are reached at stoichiometric proportions of air and fuel. For liquid fuels the heating value may be expressed as a function of the C/H ratio, which means that in this case the maximum flame temperature is a function solely of the C/H ratio.

The basic assumptions for this correlation are: (1) Maximum flame temperatures are defined at exact theoretical air requirements. (2) There are no radiation, conduction or convection losses. (3) The fuel is burned completely to carbon dioxide and water, which in turn are dissociated to equilibrium conditions at maximum flame temperature. (4) The equilibria considered are $2CO_2 = 2CO + O_2$ and $2H_2O = 2H_2 + O_2$. (5) Combustion takes place at atmospheric pressure. (6) Fuel is 100 percent hydrocarbon at 60 deg. F. (7) Air supply is dry and at 60 deg. F.

The first five assumptions are standard in flame temperature calculations and have been discussed by a number of investigators. The effect of non-hydrocarbon impurities in fuel oils on flame temperatures is negligible if the pure hydrocarbon heating value is used (see Table II). In the case of hydrocarbon gases, the usual impurity is water vapor. For methane saturated with water vapor at 60 deg. F. and 30 in. Hg, the decrease of flame temperature is of the order of 10 deg. F. For gases of higher molecular weight, the decrease of flame temperature due to saturation of the gas with water vapor at the same conditions is considerably less. Fuel and air temperatures above 60 deg. F. can be corrected for by adding the heat content of one pound of fuel and of the air requirements per pound of fuel above 60 deg. F. to the heating value of the fuel. The heat content values for liquid fuels and air may be obtained from Figs. 2, 3 and 5. Effects of air humidity can only be estimated by subtracting the heat content of the water vapor as shown in Fig. 5 from the heating value. The effect of water vapor from air humidity on dissociation losses must be neglected.

The basic correlations for calculation of flame temperatures from the C/H ratio and the heating value of the fuel are obtained by assuming that the fuel is oxidized completely to carbon dioxide and liquid water at 60 deg. F.; that the water is vaporized at 60 deg. F.; and that the carbon dioxide, water vapor, and nitrogen from the air supply are heated to the maximum flame temperature, and then dissociated isothermally to equillibrium conditions. The heating value of the fuel is balanced against the heat quantity corresponding to the minimum stack loss of Equation (20) at flame temperature, plus the heat of dissociation at flame temperature. The expression corresponding to Equation (20) for the 2,000 to 4,500 deg. R. temperature range is derived from Equations (10b), (11b), (12), (14), (15) and (16), with the latent heat of the water vapor formed during combustion included as shown in the derivation of Equation (20).

$$L_{min.} = T^{1.24}\,[(1.609 + 0.453R)/(R+1)] + [(6{,}440 - 711R)/(R+1)] \quad (30)$$

The maximum error by using Equa-

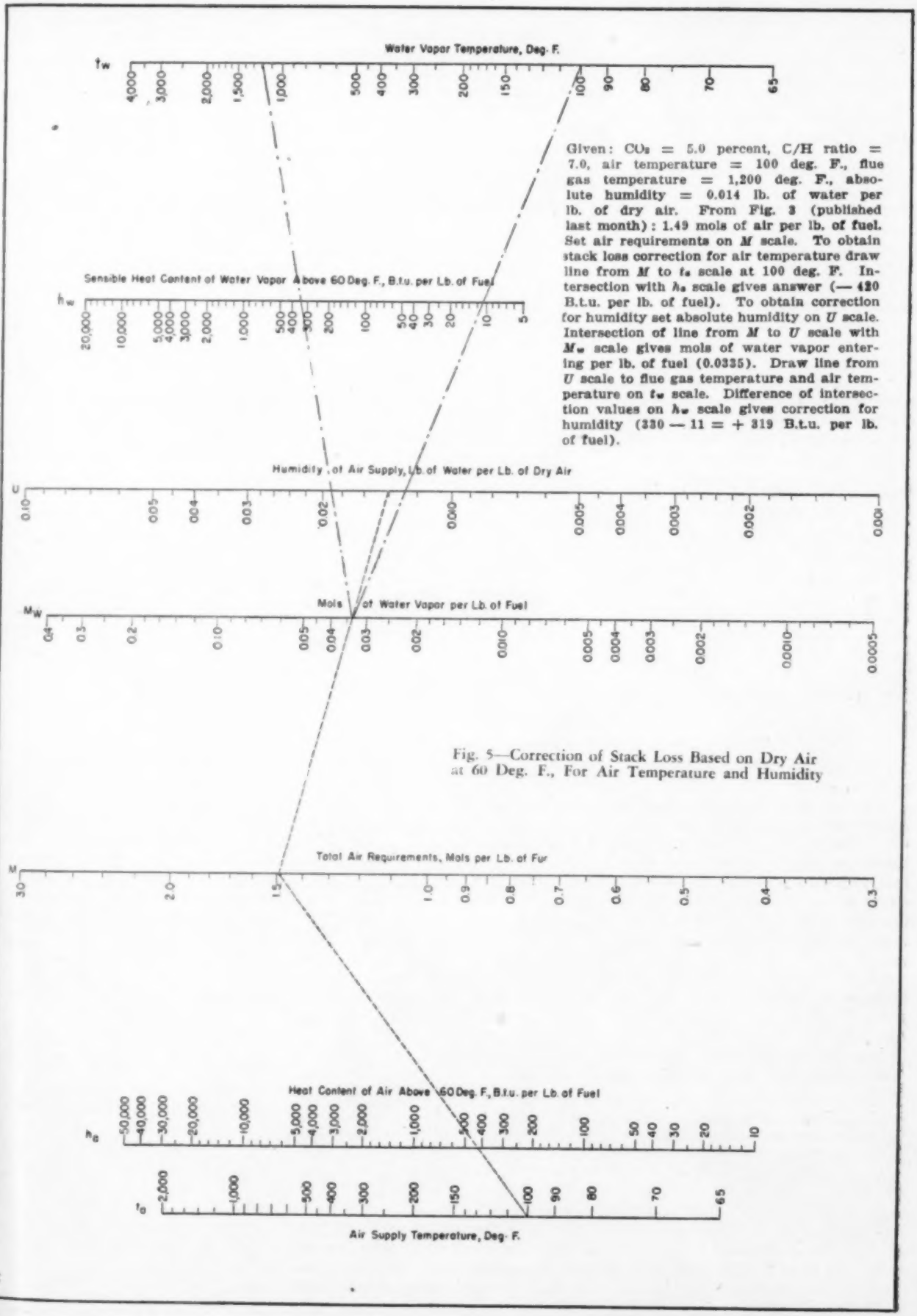
Water Vapor Temperature, Deg. F.
t_w
4,000 3,000 2,000 1,500 1,000 500 400 300 200 150 100 90 80 70 65
Sensible Heat Content of Water Vapor Above 60 Deg. F., B.t.u. per Lb. of Fuel
h_w
20,000 10,000 5,000 4,000 3,000 2,000 1,000 500 400 300 200 100 50 40 30 20 10 5
Given: CO_2 = 5.0 percent, C/H ratio = 7.0, air temperature = 100 deg. F., flue gas temperature = 1,200 deg. F., absolute humidity = 0.014 lb. of water per lb. of dry air. From Fig. 3 (published last month): 1.49 mols of air per lb. of fuel. Set air requirements on M scale. To obtain stack loss correction for air temperature draw line from M to t_a scale at 100 deg. F. Intersection with h_a scale gives answer (— 420 B.t.u. per lb. of fuel). To obtain correction for humidity set absolute humidity on U scale. Intersection of line from M to U scale with M_w scale gives mols of water vapor entering per lb. of fuel (0.0335). Draw line from U scale to flue gas temperature and air temperature on t_w scale. Difference of intersection values on h_w scale gives correction for humidity (330 — 11 = + 319 B.t.u. per lb. of fuel).
Humidity of Air Supply, Lb. of Water per Lb. of Dry Air
U
0.10 0.05 0.04 0.03 0.02 0.010 0.005 0.004 0.003 0.002 0.001
Mols of Water Vapor per Lb. of Fuel
M_W
0.4 0.3 0.2 0.10 0.05 0.04 0.03 0.02 0.010 0.005 0.004 0.003 0.002 0.0010 0.0005
Total Air Requirements, Mols per Lb. of Fuel
M
3.0 2.0 1.5 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3
Heat Content of Air Above 60 Deg. F., B.t.u. per Lb. of Fuel
h_a
50,000 40,000 30,000 20,000 10,000 5,000 4,000 3,000 2,000 1,000 500 400 300 200 100 50 40 30 20 10
t_a
2,000 1,000 500 400 300 200 150 100 90 80 70 65
Air Supply Temperature, Deg. F.

Fig. 5—Correction of Stack Loss Based on Dry Air at 60 Deg. F., For Air Temperature and Humidity

tion (30) in the range from 2,000 to 4,500 deg. R. has been calculated as 1.2 percent.

The complete equation for the flame temperature at theoretical air supply as a function of C/H ratio and gross heating value at constant pressure and 60 deg. F. is:

$$Q_p = L_{min.} + [L_d]\cos + [L_d]_{SIO} \quad (31)$$

Substituting Equations (28), (29) and (30) in Equation (31), and rearranging, the final expression correlating flame temperature (T), C/H ratio (R) and heating value (Q_p) is obtained:

$$T^{0.555}[2.83 + 1.633R + 6.43\log\{(4.783R + 17.35)/6\} + 3.33R\log\{(4.783R + 17.35)/R\}]/10^{m}[1.609 + 0.453R] + T^{1.34} = [Q_p(R+1)/(1.609+0.453R)] - [6{,}418 - 729R - 50.3\log\{(4.783R + 17.35)/6\} - 35.95R\log\{(4.783R + 17.35)/R\}]/[1.609 + 0.453R] \quad (32)$$

Equation (32) is divided into the

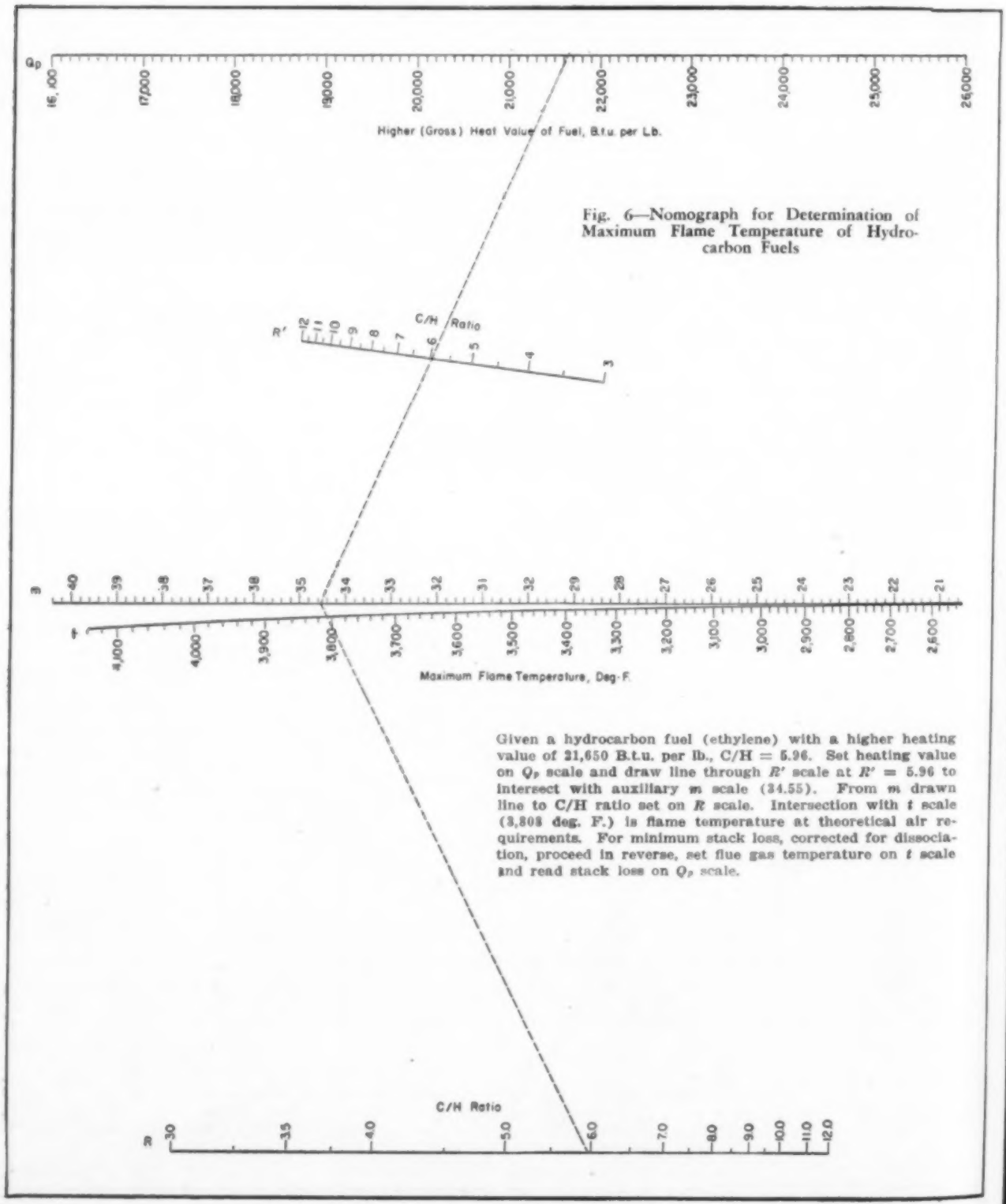

Fig. 6—Nomograph for Determination of Maximum Flame Temperature of Hydrocarbon Fuels

Given a hydrocarbon fuel (ethylene) with a higher heating value of 21,650 B.t.u. per lb., C/H = 5.96. Set heating value on Q_p scale and draw line through R' scale at $R' = 5.96$ to intersect with auxiliary m scale (34.55). From m drawn line to C/H ratio set on R scale. Intersection with t scale (3,803 deg. F.) is flame temperature at theoretical air requirements. For minimum stack loss, corrected for dissociation, proceed in reverse, set flue gas temperature on t scale and read stack loss on Q_p scale.

following form for convenience in making the nomograph to express it:

$$T^{0.555} f_1(R) + T^{1.34} = m, \text{ and}$$
$$Q_p f_2(R) - f_3(R) = m,$$

where m represents the auxiliary scale. The heating value to be used in cases of air and fuel temperatures above 60 deg. F. and with humidity, can be obtained from the pure hydrocarbon heating value at constant pressure (see Table I) and Figs. 2, 3 and 5 as discussed above. It should be noted again that the humidity correction is unsound since it does not include the over-all effect on dissociation losses.

Table III gives a comparison between the theoretical maximum flame temperatures determined by the nomograph (Fig. 6) and the flame temperatures calculated by Jones, Lewis, Friauf, and Perrott.[9] Since their calculations were made on the basis of the air and fuel gases saturated with water vapor at 18 deg. C. and atmospheric pressure, the maximum flame temperatures on a dry basis should be somewhat higher.

Table III shows that the values obtained by the two methods are comparable after the values from the nomograph (Fig. 6) have been roughly corrected for air humidity as discussed above. This correction is too low since dissociation of the water vapor from the air humidity is not taken into consideration. Another major source of deviation is the assumption that the maximum flame temperature is reached at stoichiometric proportions of fuel and air. The maximum flame temperature is actually reached when the mixture contains a slight excess of fuel. Changes in the basic thermochemical data also contribute to differences between the two sets of values.

In presence of excess air, flame temperatures can be obtained from the gross heating value and the C/H ratio of the fuel and Equations (20) and (21) (or the corresponding nomograph, Fig. 4) by a trial and error solution if either one of the following two conditions exists: (1) Flame temperature not above 3,000 deg. F. and any amount of excess air. (2) Flame temperature not above 3,500 deg. F. and 20 percent excess air or more.

This solution assumes various flame temperatures until the minimum stack loss and the stack loss due to excess air add up to the heating value of the fuel. The same corrections of the heating value for air and fuel temperatures above 60 deg. F. and humidity hold as discussed previously. For acetylene, $Q_p = 21{,}600$ B.t.u. per lb., the flame temperature at 50 percent excess air (11.5 percent CO_2 by Orsat) would be approximately 3,440 deg. F.

Discussion

The integrated system of combustion calculations based on the C/H ratio and the latest spectroscopic and thermochemical data presented here is applicable to all hydrocarbon fuels burned under conditions normally encountered. For most liquid hydrocarbon fuels, the C/H ratio can be obtained by a simple empirical method.[4] It is of sufficient accuracy so as not to affect the accuracy of the basic correlations. The only other major source of error is the assumption that the fuel is 100 percent hydrocarbon. For gaseous and distillate fuels this assumption is generally justified, while for residual fuels increasing deviations are unavoidable. Simple correction factors for such fuels can be applied and the method of their application becomes apparent from a study of the correlation in question. Only in case of heating values is such a correction of sufficient magnitude and regularity to be suggested here. For the calculation of over-all thermal efficiencies and flame temperatures it is only necessary to use the pure hydrocarbon heating value instead of the actual heating value.

Acknowledgment

Thanks are due to T. G. Rochner and E. B. Delgass of the technical service department of the Socony-Vacuum laboratories for their cooperation in making this work possible. Also appreciated are the comments and suggestions of the members of the oil burner laboratory staff of that organization and the help extended by L. A. Witte in drawing the nomograms.

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OIL EXTRACTION

(*Continued from page 141*)

and the processing equipment which is the heart of the establishment represents less than one-quarter of the entire investment. It is obvious then, that anything that can be done to insure the proper functioning of the processing equipment is a well-advised expenditure. While total installation costs vary with capacity, the proportionate costs of the basic items differ widely. This is illustrated in the following tabulation, which shows approximate figures for plants of 75 and 300 tons per day:

	Percent of Total Cost	
	75 T/D	300T/D
Land	1.0	0.5
Buildings	10.0	6.0
Process equipment*	27.0	19.0
Erection†	20.0	13.0
Storage and elevators	33.0	58.0
Boiler plant	2.5	1.5
Fire protection	4.0	1.0
Lab. and office equipment	0.7	0.3
Railroad siding	1.8	0.7

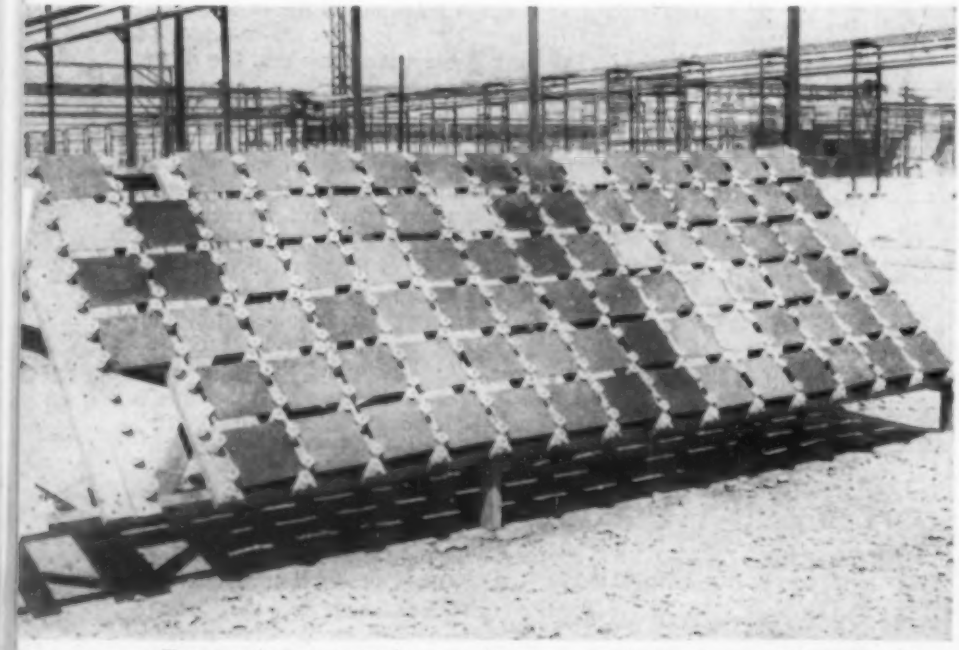
* Includes preparation, extraction, distillation, meal drying, meal tempering, conveying and bagging machinery, plus instruments. † Includes wiring, piping, and installation.

It is interesting to note that the greatest cost is storage, based on 200 days supply, which varies directly with capacity while other costs vary inversely with capacity.

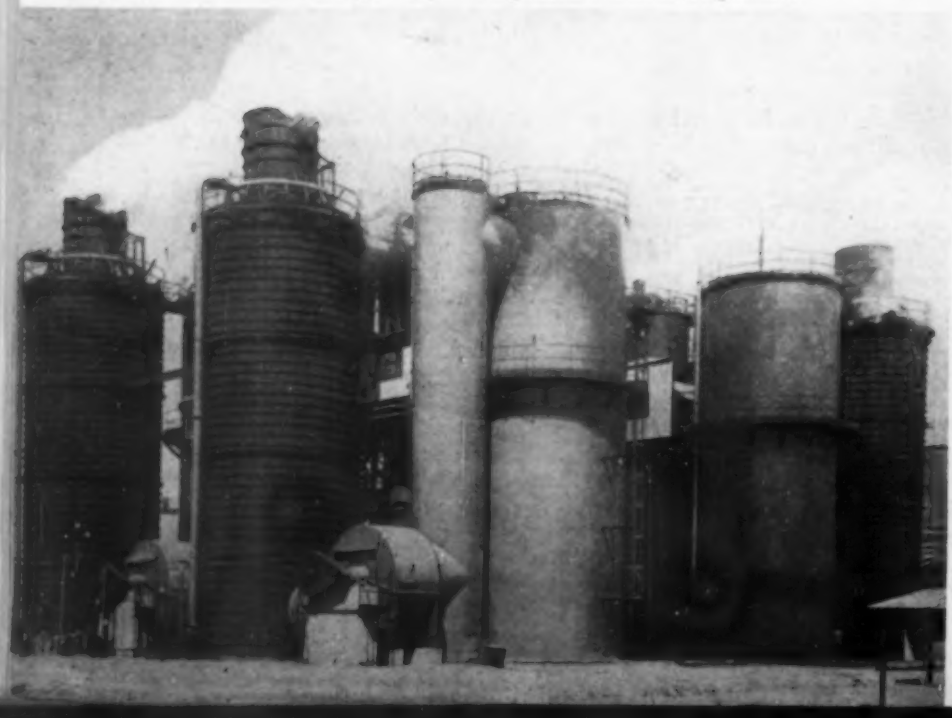
Engineering skill is essential to building successful process plants for extracting vegetable oils. It is reflected in dependable daily operation and in the quality of oil and meal produced. The present critical shortages of both these products have aroused considerable interest in solvent extraction because of higher yields and lower labor and operating costs. In normal times, however, competitive conditions will require the maintenance of a high quality product consistent with maximum yields and minimum costs.

PROTECTIVE COATINGS UNDER TEST

VAST FIELD RESEARCH SEEKS TO IMPROVE PROTECTIVE COATINGS FOR PROCESS INDUSTRY EQUIPMENT AND BUILDINGS



Test panels are exposed near salt spray, caustic fumes, magnesium chloride vapors, carbon tetrachloride plant and other locations



Typical of the conditions at plant is dense smoke containing $MgCl_2$ and HCl which pours from magnesium chloride evaporators

A UNIQUE chapter in the annals of protective coatings, which may well have far reaching effects on the future use of many industrial paints, is being written at the Dow Chemical Co. plant at Freeport, Tex. There an extensive field test program on maintenance paints is under way. The Sherwin-Williams Co. has provided 59 primers and finishes and is cooperating with the technicians of the Dow Chemical Co. in the preparation and periodic evaluation of some 1,500 paint-outs and test panels. By pooling resources, the two companies expect to achieve more nearly satisfactory results.

The immediate broad objective is to discover paints most suitable for use at the Texas plant. However, the findings also are expected to be helpful in solving painting problems in petroleum refineries, sulphur plants, paper mills and other chemical plants where similar conditions prevail.

Though the tests are still far from complete and the final evaluation of results still months away, they have already revealed much valuable information which as of this time is perhaps most important from the standpoint of disclosing a number of formulations which are wholly unsuited for the specific application.

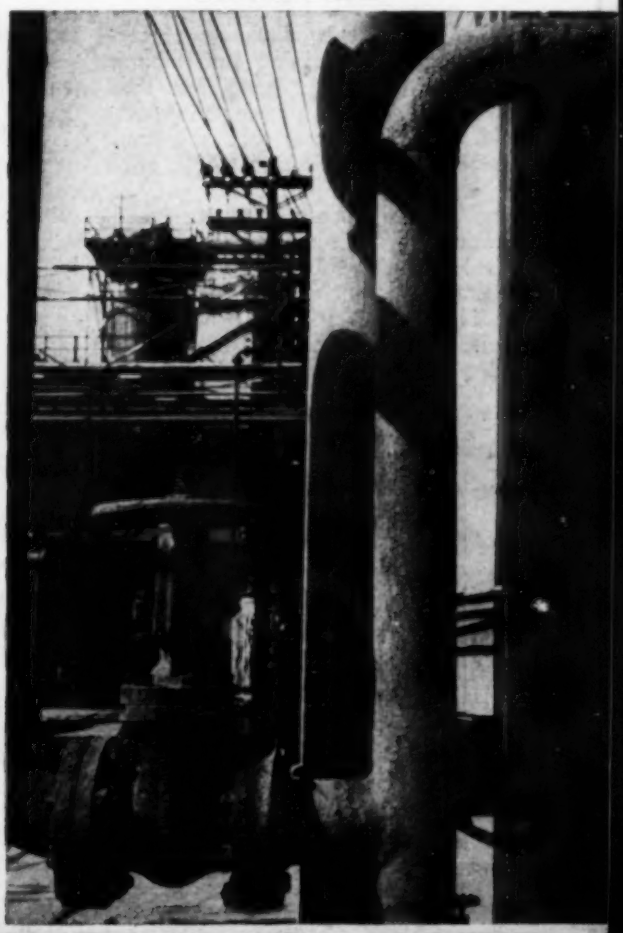
Perhaps no better proving ground for industrial paints could be found anywhere. Geographic location and nature of production at Freeport combine to create the severest sort of atmospheric and chemical exposure conditions. Seashore exposure makes air so salt-laden that unprotected steel deteriorates badly in a few months.

Because of the psychological importance of color from the viewpoint of the Dow Chemical Co., permanence of color in the paint holds nearly as much importance as long-lasting protective qualities.

Dow Chemical Co. plant at Freeport, Tex., where Dow and Sherwin-Williams Co. are collaborating in a series of tests to discover paints which will better withstand severe atmospheric conditions and resist chemical fumes

Coatings have been applied on surfaces of tanks and equipment as well as on special test panels exposed on racks

Control valve and piping corroded by chlorine and other chemicals



THE PLANT NOTEBOOK

Theodore R. Olive, ASSOCIATE EDITOR

$50 CASH PRIZE FOR A GOOD IDEA!

Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. The winner each month will be announced in the issue of the next month: e.g., the May winner will be announced in June, and his article published in July. Judges will be the editors of *Chemical Engineering.* Non-winning articles submitted for this contest will be published if acceptable, in that case being paid for at applicable space rates.

Any reader of *Chemical Engineering,* other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Neither finished drawings nor polished writing are necessary, since only appropriateness, novelty and usefulness of the ideas presented are considered.

Articles may deal with any sort of plant or production "kink" or shortcut that will be of interest to chemical engineers in the process industries. In addition, novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering,* 330 West 42nd St., New York 18, N. Y.

APRIL WINNER

A $50 prize will be issued to

JOHN W. POSTLER
Chemical Engineer
Cincinnati, Ohio

For an article describing an ingenious pressure-compensating seal for pump and agitator shafts in solvent handling and corrosive service, that has been judged the winner of our April contest.

This article will appear in our June issue. Watch for it!

March Contest Prize Winner

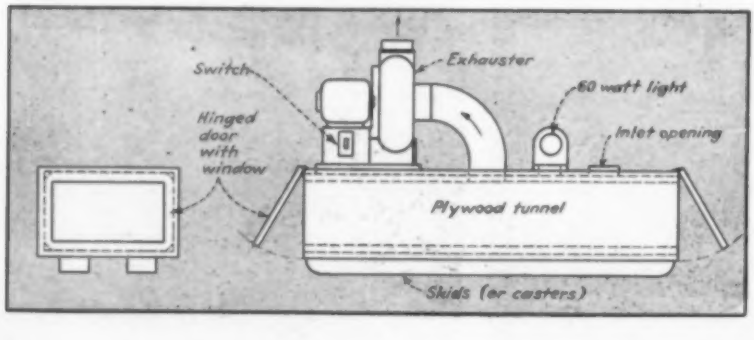
PORTABLE VENTILATED TUNNEL AIDS IN DISCHARGING KETTLE CONTENTS WHEN TOXIC GAS IS PRODUCED

F. A. MITCHELL
Evans Chemetics, Inc., Waterloo, N. Y.

FREQUENTLY in pilot plant work it is necessary to discharge a reaction kettle containing hot molten chemicals before they are cooled. This is usually done by allowing the material to run into pans, cooling it until solid and then breaking it up. In cases where the molten chemicals give off considerable quantities of toxic and irritating gases, some means must be used to remove the gases. In an open room this is not easily accomplished.

This problem was conveniently solved by constructing a tunnel complete with a blower and which could be easily moved under the discharge spout of the kettle. The tunnel, suggested in the drawing, can be constructed of plywood with a hinged door at each end. Each door has a glass window so that the material can be observed. The blower is mounted on the top, as well as a peep sight and suitable light. The light and blower are connected to a common switch for convenience. The unit can be mounted on casters if desired. One or two pans of 15 × 24 × 6 in. size, constructed from a suitable metal, are also required.

Pans in this ventilated tunnel receive fuming material from a kettle



The unit is moved under the kettle so that the 4-in. opening is directly under the discharge valve. A pan is pushed into the tunnel so as to receive the material. With the blower discharge connected to a flexible rubber duct or a regular metal duct if desired the fumes are exhausted outdoors or into the regular hood. As soon as the first pan is filled the second pan is used to push the first further into the tunnel, which brings it into position to receive the material. This can usually be accomplished without interrupting the flow. If necessary to use more than two pans, the tunnel can be long enough to accommodate three or four pans. In that case it will be necessary to install a roller conveyor in the tunnel so that the pans can easily be moved along.

CEMENT REPAIRS VINYON FILTER CLOTHS

JOSEPH KARSLO
Philadelphia, Pa.

WHEN Vinyon filter cloths develop holes they usually are discarded for fine filtration work. Vinyon yarns are mono-filaments and small holes do not close up with fuzz as they do in cotton or wool cloths. For the same reason patches can not be sewed on, since the needle makes numerous holes that are just as objectional as the original hole. This situation re-

sults in considerable expense if conditions are such that holes in the cloth are easily produced, especially where the clear filtration of a slimy fine precipitate is required. Such damaged cloths can be repaired as follows.

A cement is made of Vinyon dissolved in ethylene dichloride. Enough Vinyon is dissolved to give a viscous sirup. For 50 grams of Vinyon about 500 to 800 cc. of $C_2H_4Cl_2$ is satisfactory. A tiny patch of Vinyon cloth sufficient to cover the hole or tear is cut out. The patch is coated with the cement and pressed over the hole. When dry the patch will adhere to the cloth so firmly that in effect it is part of the main cloth. The $C_2H_4Cl_2$ in the cement softens the surface layers of fibers in patch and cloth and results in a firm bond between the two. Pure $C_2H_4Cl_2$ should not be used since it will soak right through the cloth and make a bigger hole. The viscous sirup remains on the surface and has the additional advantage of supplying filler in the form of Vinyon which is just as tough and flexible as the original cloth.

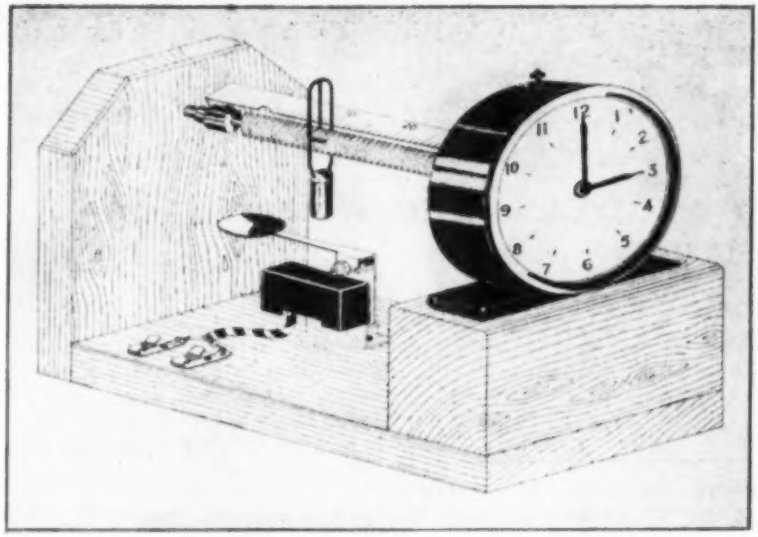
For portions of filter cloth where patches are undesirable such as on bearing surfaces where filter press plates meet, the cement can be used directly without a patch. A drop applied to the hole and allowed to dry fills the hole with Vinyon.

TIME SWITCH SUITABLE FOR ALL EXPERIMENTAL WORK

J. S. CHARLESWORTH and E. TIPMAN
Respectively, Chief Chemist and Assistant Chemist, Gasoline and Oil Laboratory Research Council of Alberta
Edmonton, Alberta, Canada

IT IS often necessary in laboratory work to start or stop operations automatically. Many tests are of long duration and where only one shift is maintained mechanical timers are required for control in off-shift hours. The timeswitch shown here is both simple and inexpensive to construct. It will operate well for all time intervals and is limited only by the length of time the clock will run.

The essential parts consist of an ordinary alarm clock, a grooved shaft with pivot bearing, a rider and small switch. The shaft illustrated is machined from ½-in. aluminum stock. The groove is cut with a round-edge lathe tool cutting a lefthand thread at 10 threads per inch. Close to one end of the shaft the diameter is reduced to about ⅛-in. to allow the rider to fall. The rider is made from ½-in. brass stock. The heavy wire frame with central pivot arm and guide arms are brazed together as illustrated.



Clock operates switch any time up to 40 hr. after setting

The shaft is attached with a rubber connector to the setting knob of the clock which turns once an hour. To set any desired interval the rider is moved up the shaft the required number of threads. For convenience in setting, a scale is attached. As the shaft rotates the rider moves along the groove and finally falls on an ordinary commercial Micro-Switch to either close or open a circuit, with or without a relay.

The timer so constructed in this laboratory cost about $6 and operates on any time interval up to 40 hours. On repeated tests the rider has been found to fall within 20 seconds of the set time.

HIGH TEMPERATURE SEAL FOR ROTATING SHAFT

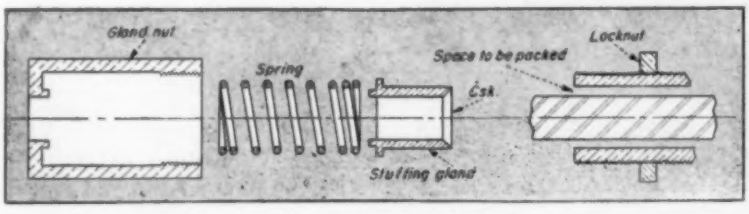
F. B. EASTMAN and H. O. McMAHON
Arthur D. Little, Inc., Cambridge, Mass.

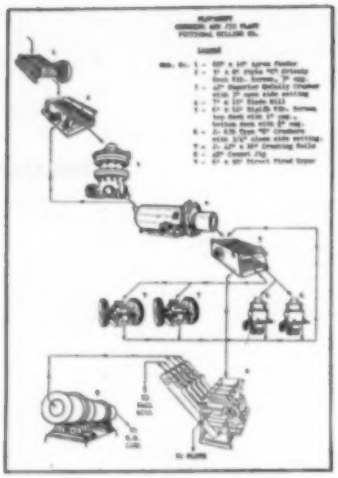
PUMPING of liquids at elevated temperatures (up to 700 deg. F.) has long been unnecessarily complicated by the problem of shaft gland leakage. As discussed by Schrader and DeHaan (*Chem. Eng.*, 53, 100, Nov. 1946), Teflon (polytetrafluorethylene) lathe shavings dusted with a lubricant such as graphite produce a corrosion-resistant stuffing box seal. In connection with an independent research on tetracresyl silicate as a liquid heat transfer medium (U. S. Patent 2,335,012) it has been found that this packing may also be used satisfactorily at elevated temperatures, with simple pump modifications.

Teflon is chemically inert and will stand temperatures as high as 700 deg. F. without softening. In the form of shavings or shredding this material will, when packed in a gland, form a fine labyrinth through which the hot liquid must pass in order to achieve freedom to the admosphere. As the temperature of the liquid rises, the Teflon expands causing the labyrinth space to diminish. This tends to counterbalance the effect of the change of viscosity and increase in "creep" characteristic of the liquid. The expansion of the Teflon in the annular space creates a problem because of the tendency of the material to thermomold. Thermo-molding causes distortion of the labyrinth to such an extent that the gland will leak if the system is allowed to cool. This difficulty is overcome however by spring loading the gland in such a fashion as to allow the Teflon to expand without thermomolding. It has been found that the proper degree of load on the spring may be determined by increasing tension with the system cold until seepage stops.

Referring to the accompanying sketch, an entirely conventional centrifugal pump may be modified to the

Spring-loaded stuffing box for high-temperature pumps





Flowsheet made with rubber stamps

extent of lengthening the gland nut to accommodate the spring which in turn seats against the stuffing gland. It has been found that the spring loading of the stuffing box gland with Teflon as a packing material has materially reduced the equipment costs in pilot and small process plants requiring high-temperature pump service.

RUBBER STAMPS SPEED FLOWSHEET MAKING

RUBBER STAMPS molded from zinc cuts have proved a great aid in helping to produce graphic flowsheets quickly, accurately and inexpensively for the product departments of Allis-Chalmers Mfg. Co., at Milwaukee.

At the outset, in an effort to secure the advantages of a pictorial flowsheet without the high cost involved, Stanley D. Michaelson, director of the company's basic industries research laboratory, and originator of the plan now in use, experimented with various devices including templates, which were not too successful.

In contemplating the use of rubber stamps for each machine, perspective line sketches were first prepared from equipment photographs. Zinc cuts were then made from these sketches and the rubber stamps finally molded from the zinc cuts. These stamps are used with a pad saturated with an opaque type black stamp pad ink and an impression of the proper machine made at the appropriate place on the chart. Flow lines and descriptive information are then added as needed. With the use of good tracing paper and proper stamp pad ink, excellent prints can be made from the original.

94 Percent Saving

An imaginary flowsheet reproduced here was made with nine different rubber stamps and required only a half hour to draft, compared with about eight hours for an equivalent pictorial flowsheet made by a draftsman.

The cost of producing the stamps is not high. For each stamp the zinc cut costs about $3, and from this any number of rubber stamps can be made at a cost varying from $1 to $2.50 depending upon the size of the stamp.

Pictorial flowsheets facilitate understanding of equipment layouts but are seldom made because of their expense. Mr. Michaelson's method should prove highly advantageous to all who make many flowsheets in the normal course of operations.

FLOATING FUME BLANKET

This view shows a novel use for plastic tubes, developed by the Udylite Corp., Detroit, for blanketing chrome-plating baths in sufficient depth to protect workmen from the chromic acid fumes, and prevent loss of acid spray. The tubes are of Dow's Styron, extruded and then closed at the ends to resemble miniature pillows.

120 CUT TO 7½

This view shows how a 120 man-day job of steel setting was cut to 7½ man-days in the construction of a Chicago plant. The reinforced concrete second floor of the structure had been completed and the problem was then to set the building steel. To have done so with the conventional pole, block and tackle, etc., it was estimated, would have required 12 men for 10 days. The alternate method, hoisting a small crane to the second floor and setting the steel from that level, required the services of five men for 1½ days. A conventional crane of sufficient capacity would have been so heavy as to require a 1 to 1½-cu. yd. crane to lift it to the second floor, but the small all-hydraulic 2-ton Milwaukee Hydraulics Corp. crane chosen was light enough to be lifted readily with a ½-cu. yd. truck crane, thus saving expense and a variety of complications.

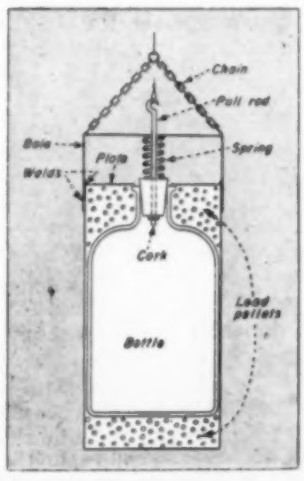
RUGGED SAMPLING BOTTLE MADE FROM SCRAP

PAUL C. ZIEMKE
Chemical Engineer
Oak Ridge, Tenn.

SHOWN HERE is a diagram indicative of a sturdy sampling bottle that will serve the plant for many years. The body is cut from section of 6-in. malleable pipe, 16 in. in length. After pouring in an inch of scrap lead slugs or pellets to form the ballast a bottle of suitable size is inserted in the sleeve and permitted to rest on the ballast. The voids on either side of the bottle neck are then filled in with additional lead ballast. Next the bottle is sealed with a circular section of plate provided with a hole through which the cork can pass with ease. This plate is secured in place by tack welding. The bale or hoop is bent from a section of 1 x ¼-in. strap which serves the dual purpose of acting as a guide for the cork restoring spring and the hoisting chain attachment.

In practice the weighted bottle is lowered to the required depth at which the sample is to be taken. The cord attached to the pull rod is hauled upward until the spring is compressed, which permits the sample to flow into the bottle. The second line attached to the crotch chain is then used to hoist the sampler to the surface. If the bottle must be sent to the laboratory the strap iron hoop serves well as a handle.

A sturdy sampling bottle can be constructed of scrap as shown



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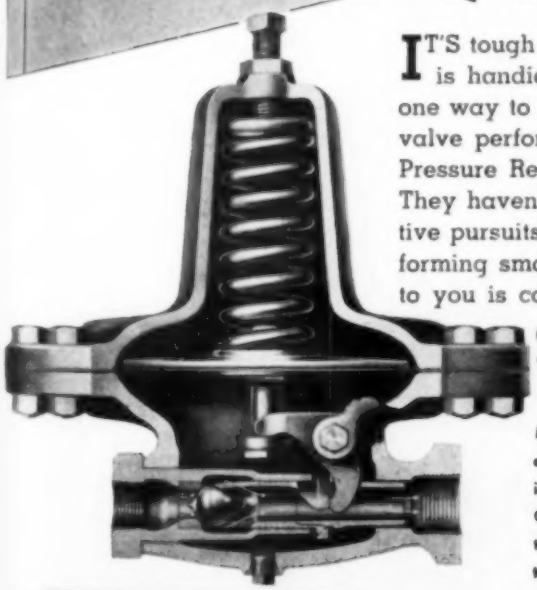
CASH STANDARD Streamlined PRESSURE REDUCING VALVES TYPE 1000

IT'S tough going and costly too when production is handicapped by these six culprits. There is one way to fully protect against them as concerns valve performance. The "Streamlined" Type 1000 Pressure Reducing Valve ties 'em hand and foot. They haven't a chance to engage in their destructive pursuits with the Type 1000 on your lines performing smoothly and dependably. The net result to you is continuous savings and no trouble.



Our bulletin "962" gives you the entire "1000" story.

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Maximum Capacity When Needed Most • Accurate Pressure Control Under Toughest Working Conditions • Trouble-Free Service • Smooth Operation • Tight Closure • Accurate Regulation • Speedier Production Results • Elimination of Failures • Constant Delivery Pressure • Cost Saving Operation • No Spoilage • Practically Zero in Maintenance Costs.

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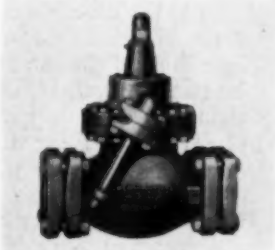
Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

Tall building houses new plant for solvent extraction of cottonseed and other vegetable oils. Older press plant is in rear

VEGETABLE OIL

THE FLOWSHEET and photographs shown here are taken from the new cottonseed processing plant of Delta Products Co. in Wilson, Ark. The installation was designed by Allis-Chalmers and is the first commercial size continuous solvent extraction plant ever built to produce cottonseed oil. Daily capacity is 200 tons of seed and there is an extra yield, as against extraction by hydraulic pressing, expected to reach about 45 lb. of oil per ton of seed.

Although the plant shown here happens to be working on cottonseed, the unit processes, sequence of operations, and general arrangement of equipment are quite typical of any solvent extraction plant no matter what the oil-bearing seed may be. (See article pp. 139-141.) The first job is to break down the cellular structure of the seed so that the solvent has access to the oil it must remove. This, as the flowsheet shows, includes cracking, steaming, and flaking. The prepared meats are carried by belt conveyor to the top of the extractor where they descend by gravity through an upward current of a solvent, in this instance hexane. The extractor consists of a series of sections separated by slotted plates with a central shaft and revolving paddles above each plate. Solvent overflows the top of the extractor, carrying the oil and bits of solids with it. This mixture of oil and solvent, called miscella, is clarified first in a centrifuge and then a plate-and-frame filter. From now on the operation is devoted to removing and recovering the solvent—from both the meal and the miscella. The meal is elevated above the solvent level, squeezed fairly dry, and the final traces of solvent driven off in dryers. The solvent vapors are scrubbed with hot water to remove meal fines, then condensed.

Getting the solvent out of the miscella is not so simple. From the filtrate tank it goes through two preheaters to raise its temperaure almost to the boiling point of the solvent, then into a long-tube high velocity evaporator. The evaporator discharges into a flash chamber where most of the solvent vapors pass off overhead to a condenser. The small amount of solvent that still remains in the oil is pulled out in a vacuum stripping column. The oil flows down from tray to tray against a rising stream of live steam, which is drawn off overhead and condensed with the solvent. The solvent and water mixtures from the two condensers are separated in a continuous decanter. Oil from the bottom of the stripping column is now free of solvent and is ready for storage and eventual shipment to a refinery.

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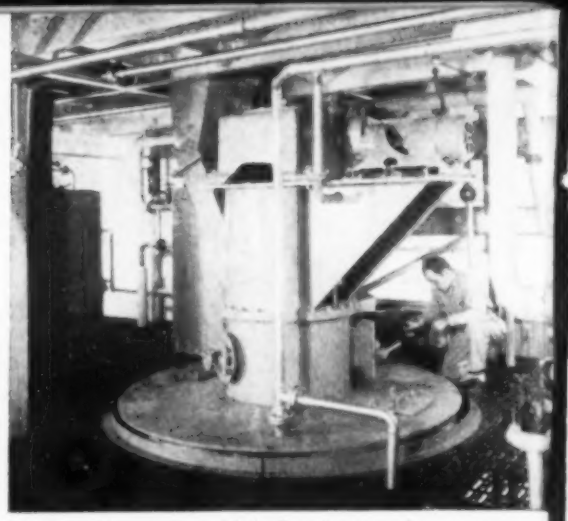
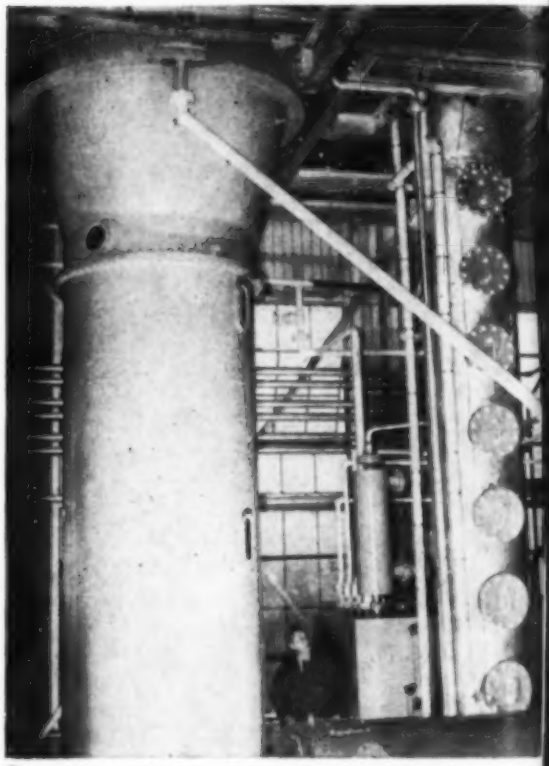
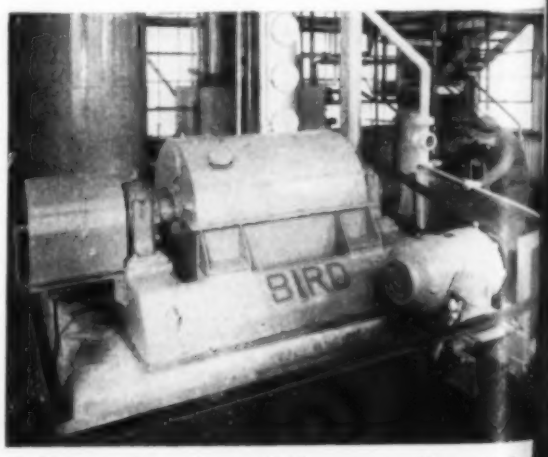


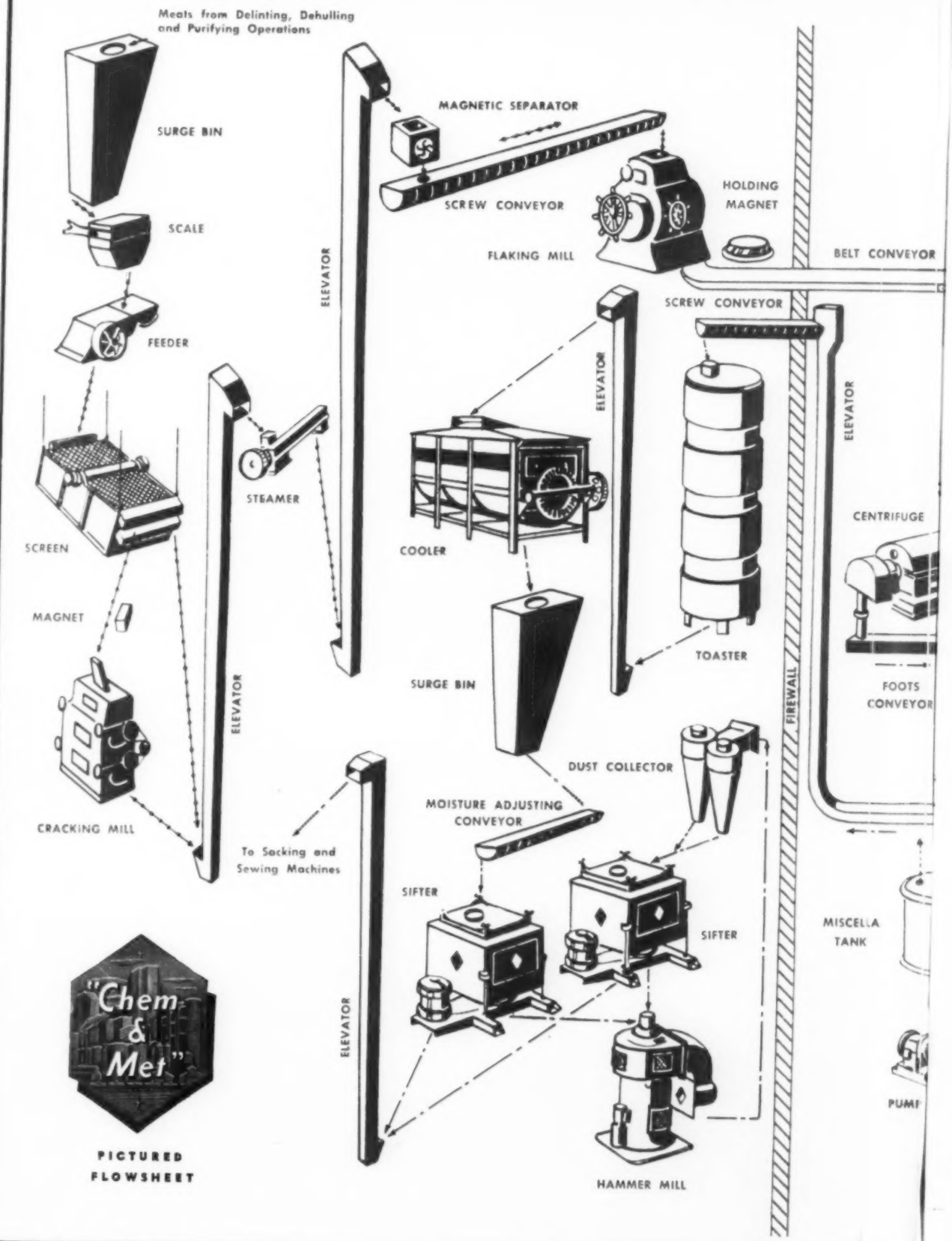
1 Top of extractor. Flaked and steamed meats enter here and pass down through rising stream of solvent



2 Alpha and omega. Extractor, left, is first step in extraction. Vacuum stripping column, right, is last



3 Horizontal continuous-discharge centrifuge clarifies miscella (solvent-oil mixture) from extractor



Doubl

Lukenweld

JACKETED

DRIER

By restricting the steam to the s by the inner and outer shells of Roll, greater steam velocity res duces film, dead steam and a through the shell.

These advantages, plus the steam passage, result in the mai perature across the face of the

Because of the strength of st higher steam pressures than eve efficient operation and increase

Complete information on the is in Bulletin 358. For a copy Division of Lukens Steel Compa ville, Pa.

LUKE

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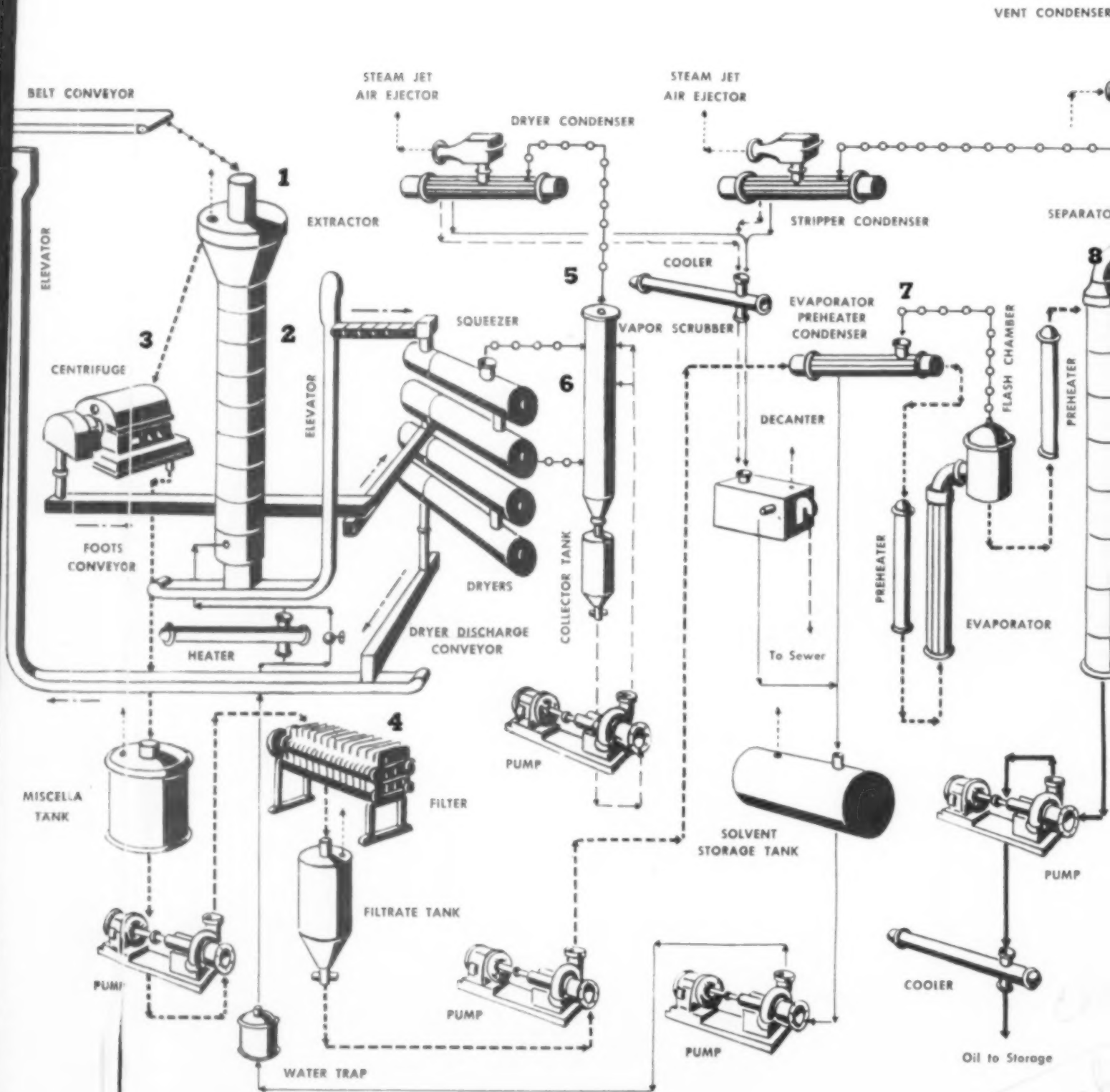
LEGEND
Meats
Oil
Meal
Miscella
Solvent
Water
Vapors
Vent
VENT CONDENSER
BELT CONVEYOR
STEAM JET AIR EJECTOR
DRYER CONDENSER
STEAM JET AIR EJECTOR
STRIPPER CONDENSER
SEPARATO
ELEVATOR
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EXTRACTOR
COOLER
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EVAPORATOR PREHEATER CONDENSER
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SQUEEZER
VAPOR SCRUBBER
CENTRIFUGE
6
ELEVATOR
DECANTER
FLASH CHAMBER
PREHEATER
FOOTS CONVEYOR
DRYERS
COLLECTOR TANK
PREHEATER
EVAPORATOR
DRYER DISCHARGE CONVEYOR
HEATER
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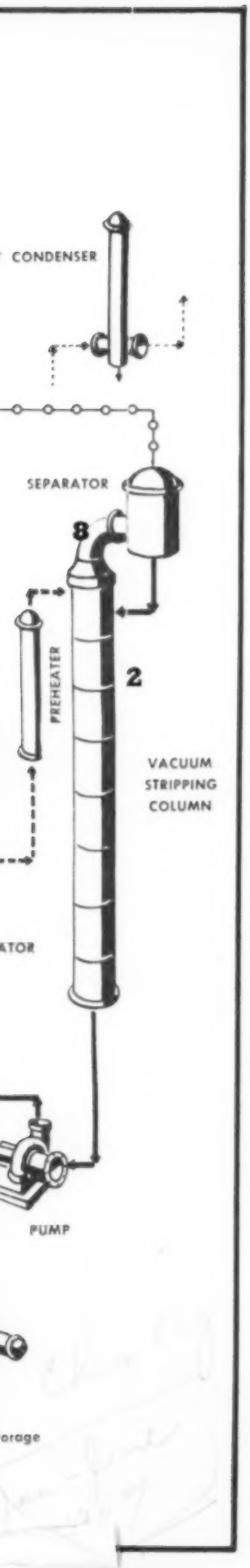
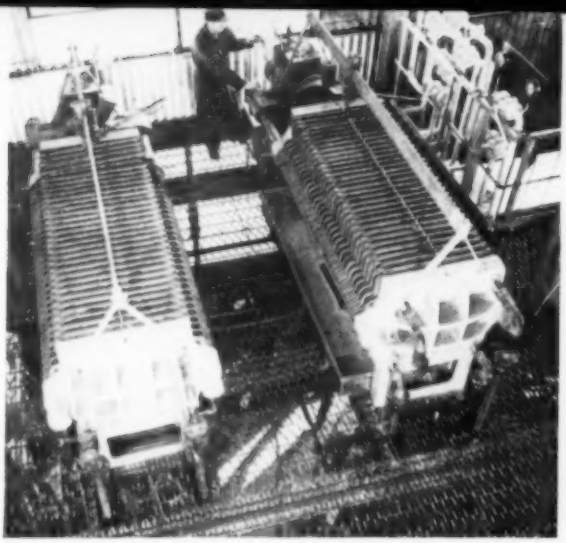
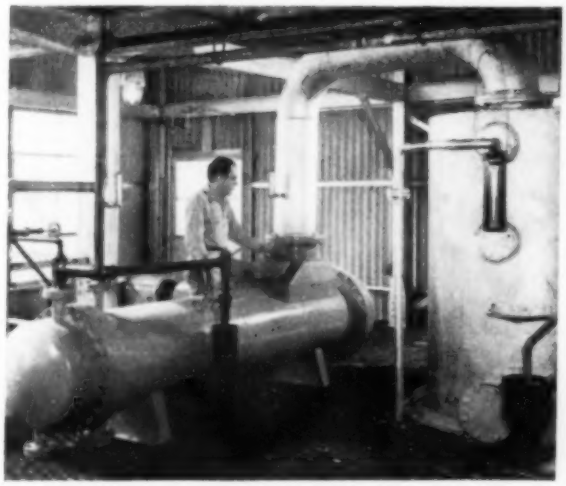
WATER TRAP
Oil to Storage

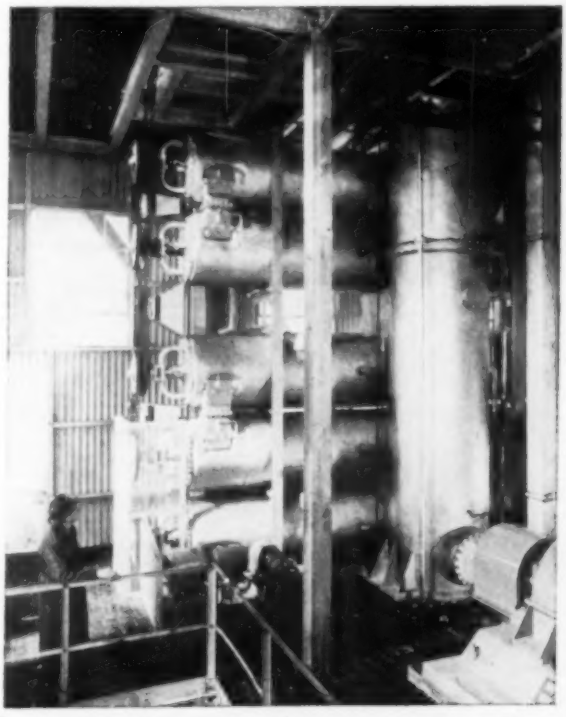




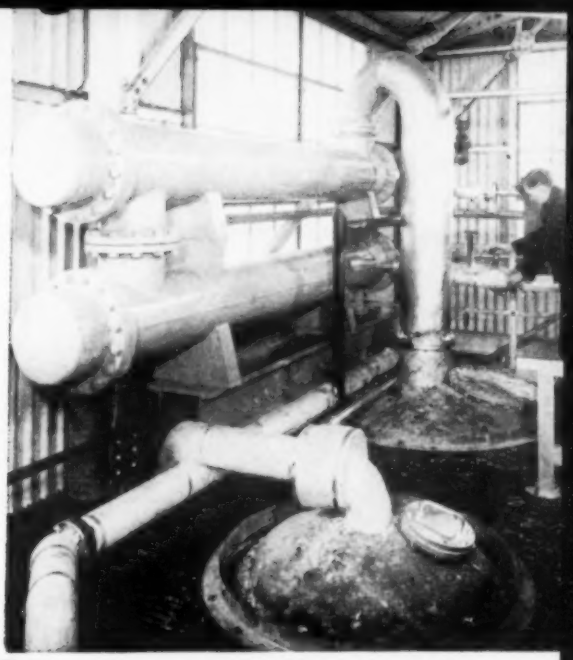
4 Two plate-and-frame filters arranged in parallel supplement centrifuge in clarification of miscella



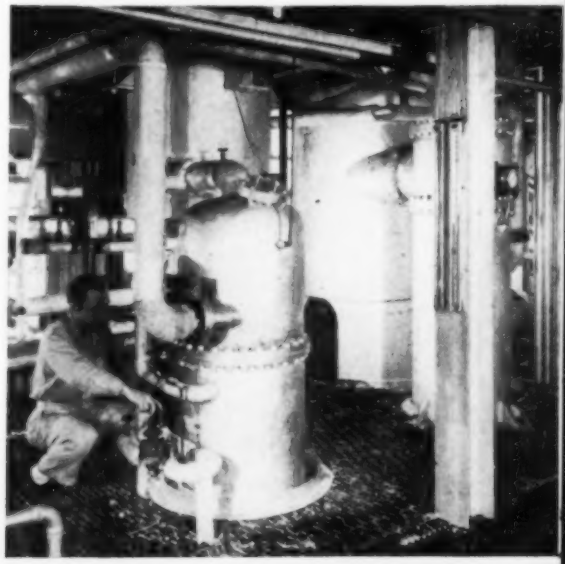
5 Dryer condenser with connection to top of vapor scrubber. Condensed solvent and water go to decanter



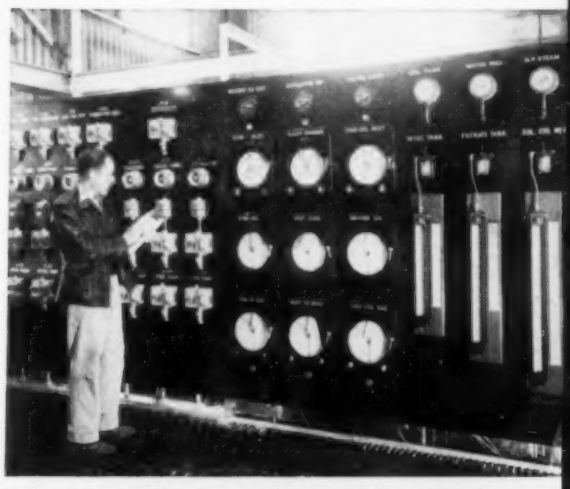
6 Top tier of seven chain-driven meal dryers. The scrubber on right cleans solvent vapor from dryers



7 Tops of separator and flash chamber with latter connected to evaporator preheater condensers



8 Stripping column connected to its separator and evaporator (behind column) to its flash chamber



Solvent extraction is continuous and automatic. Most of consolidated control panel is shown here

Double-Shell Steel Plate Construction

... engineered to give GREATER steam velocity ... MORE UNIFORM surface temperature

Patents applied for

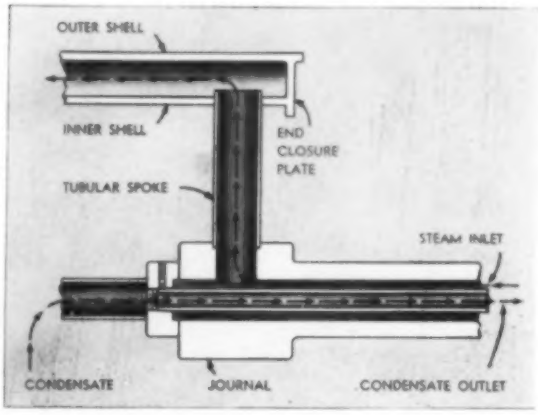
Lukenweld JACKETED DRIER ROLLS for more production

By restricting the steam to the shallow annular chamber formed by the inner and outer shells of the Lukenweld Jacketed Drier Roll, greater steam velocity results. Greater steam velocity reduces film, dead steam and air and improves heat transfer through the shell.

These advantages, plus the guiding feature of this narrow steam passage, result in the maintenance of a more uniform temperature across the face of the roll.

Because of the strength of steel plate, rolls can be made for higher steam pressures than ever practical before, assuring more efficient operation and increased production.

Complete information on the Lukenweld Jacketed Drier Roll is in Bulletin 358. For a copy please write to Lukenweld, Inc., Division of Lukens Steel Company, 400 Lukens Building, Coatesville, Pa.



Typical design of Jacketed Drier Roll showing one-quarter section of roll.

LUKENS
LUKENWELD DIVISION

*From 2 ft. to 18 ft. O. D. and over.

DRIER ROLLS AND DRYING MACHINERY

40 to 60% LESS WEIGHT!

New CRANE PRESSURE-SEAL BONNET VALVES

The scales show this weight-saving achievement . . . with no loss of strength . . . that cuts piping erection and maintenance costs. Note comparative weights of this new Crane design and the conventional 1500-Pound Steel Gate Valve, both 8-inch. Size for size, here is amazing weight-reduction . . . 40% to 60% . . . depending on size.

OTHER BASIC ADVANTAGES OF THIS NEW PRINCIPLE

1. *Eliminates Bonnet Joint Leakage*
2. *Ends Bonnet Joint Maintenance*
3. *New Streamlining . . . inside and out*
4. *New Ease of Inspection*
5. *New Ease of Operation*
6. *Improved Flow Characteristics*
7. *Reduced Over-all Dimension*

REVOLUTIONARY DESIGN IN STEEL VALVES FOR HIGH PRESSURES AND HIGH TEMPERATURES

No valve improvement in a quarter-century compares with the Pressure-Seal Bonnet principle. It completely eliminates the customary flanged bolted bonnet joint with its problems of leakage and maintenance. The joint is inside the valve—automatically sealed by fluid pressure. This new principle, as applied by Crane, brings a whole new set of standards for on-the-job valve efficiency.

The Crane Pressure-Seal line includes gate, globe, angle, and automatic stop-check patterns with welding ends. Complete information regarding performance and adaptability to your requirements supplied on request.

1500-Pound Crane Pressure-Seal Bonnet Globe Valve

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas.

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

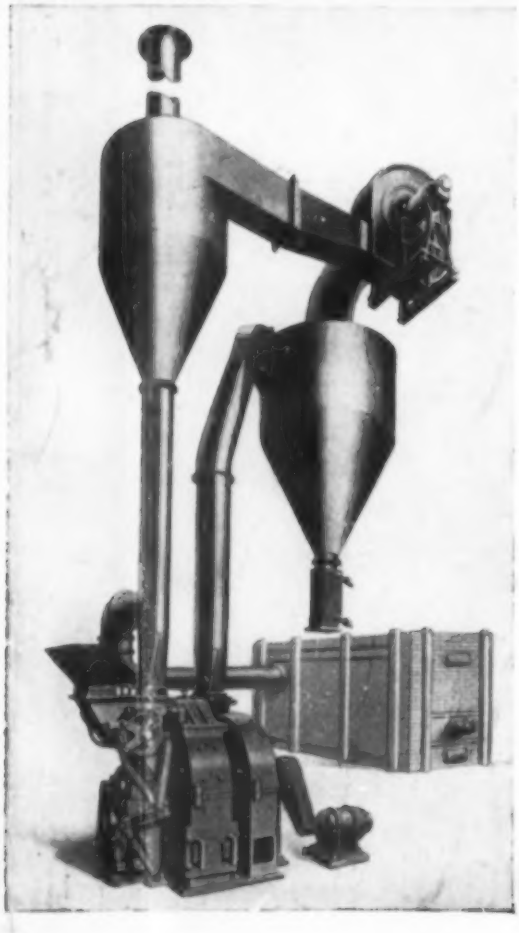
CRANE

FOR EVERY PIPING SYSTEM

RAYMOND IMP MILL

for drying and grinding in one combined operation

COPPER SULPHATE CRYSTALS REDUCED TO POWDER



FLASH DRYING and fine grinding with the Imp Mill can be applied to many different problems in the chemical, food and process industries. It lowers costs by eliminating separate dryer equipment. It improves quality by providing close control over the finished product.

A typical application is the simultaneous drying and pulverizing of copper sulphate. The material is fed to the mill in crystal form while heated air is passed into the grinding chamber. A definite temperature is maintained to remove a certain percentage of the "water of crystallization," and the product is reduced to a fine powder. The result is a mono-hydrated copper sulphate . . . a uniform, free-flowing product of superior quality.

The flash drying system may be used with Raymond Roller Mills and Cage Mills for such operations as converting industrial wastes into marketable by-products, handling filter cake of various kinds, diatomaceous earth, kaolin, chemical and food products, calcining gypsum, and turning out a host of specialty products.

Write for further details, if you have a drying-grinding problem.

Combustion Engineering Company, Inc.

Raymond Pulverizer Division

1311 N. Branch St. Chicago 22, Illinois

Sales Offices in Principal Cities

Canada: Combustion Engineering Corp., Ltd., Montreal

PROCESS EQUIPMENT NEWS

Theodore R. Olive, ASSOCIATE EDITOR

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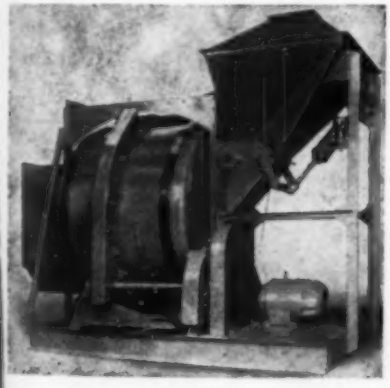
1. Glass-Batch Mixer

SUITABLE for mixing a wide variety of dry batches including not only glass but also enamel frits, refractory cements, all kinds of furnace charges, and the like, is an improved rotary mixer announced by the Ransome Machinery Co., Dunellen, N. J. This mixer, shown in the accompanying illustration, features an inclosed drive reduction gear with V-belt drive from gear box to motor; cut teeth on the large drum gear ring and pinion for smooth and quiet operation; air-operated cylinders for the discharge chute and batch hopper gate control; and either push-button control or electrical timing and interlocking devices. The



50 cu.ft. dry batch mixer

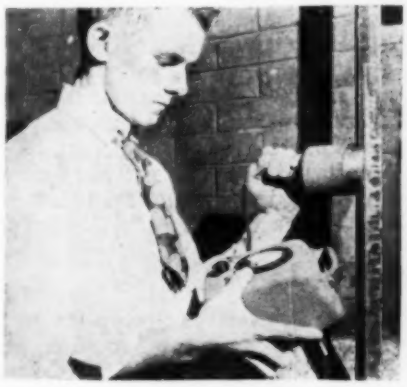
mixer employs a dustproof housing over the discharge chute, renewable liner plates, an improved dust seal and a new mixing blade arrangement. Standard sizes range from 13 to 120 cu.ft., the 50 cu.ft. model being shown in the accompanying view.

2. Pipe Thickness Gage

DESIGNATED as Type MS-A, a new thickness gage for measuring the thickness of iron or steel pipe from the outside has been announced by the Special Products Division of General Electric Co., Schenectady, N. Y. The instrument is suitable for pipe up to ½ in. in thickness and from 1 to 2 in. in diameter. The gage consists of an indicating instrument, a gage head, and a saddle which is connected to the gage head by two screws. A different saddle is required for each diameter of pipe. To operate, the saddle is placed upon the pipe and the thickness is indicated in fractions of an inch on the indicating instrument.

The gage measures the average thickness of a pipe over an area of several square inches with an accuracy of plus or minus 1/64 in. on clean surfaces, or 1/32 in. on dirty surfaces. Dirt and scale on the inside do not add to the thickness reading.

The same manufacturer has announced a new flaw detector for continuously detecting and counting holes, weak spots, and conducting paths in thin materials such as paper, sheet rubber, plastic materials, nonconducting films on wire, and similar applications. The detector can be applied to sheet materials up to 0.025 in. thickness, moving as fast as 450 ft. per min., and to wire moving up



Pipe thickness gage in use

to 100 ft. per min. It consists of an electrode assembly through which an adjustable voltage is applied to the material undergoing test, and an electronic circuit which indicates the flow of current through the material which occurs when a flaw passes under the electrode. Alarms or recorders can be used, if desired.

FOR MORE INFORMATION
See Reader Service Coupon on pages 183-184

3. High-Vacuum Recorder

FOLLOWING the development of the Model MR Televac vacuum indicating and recording unit which is described in our March 1945 issue, George E. Fredericks Co., Bethayres, Pa., has announced the Model S instrument which is provided with a dual range of 0 to 0.4 microns and 0 to 500 microns. Thus the instrument serves both for ultra high-vacuum processes as well as for those of more moderate requirements. The instrument employs this company's E-31 ionization gage for the range from 0 to 0.4 microns and the No. 500 thermal gage for the 0 to 500 micron range.

Gages are said to be interchangeable without recalibration and are guaranteed for 1,000 hours service. A safety

Dual range high vacuum recorder

circuit incorporated in this model makes it impossible to turn on the ionization gage until a vacuum of at least 1 micron has been reached, thus avoiding any possibility of burning out the gage. Should the pressure rise for any reason above 1 micron, the gage filament instantly and automatically shuts off. It is claimed that no technical knowledge is necessary to operate the gage nor can it be harmed by unskilled persons.

4. Portable Electric Hoist

ROLLER-CHAIN electric hoists in ¼, ½ and 1 ton capacity have been announced by the Whiting Corp., Harvey, Ill. The 1-ton hoist weighs only 87 lb. and so can be installed or moved by one man. These hoists utilize a simple double-reduction, totally inclosed worm gear drive to insure compactness and light weight. Safe operation is provided by a patented self-energizing motor brake. The unit is provided with upper and lower limit switches. An unusual feature is that the hoist can be operated in an inverted position if necessary.

5. Sheet-Plastics Creaser

AS A COMPANION to the machine described in our October 1946 issue, which was developed to produce 180-deg. folds in sheet plastics, the Plastics Equipment Division of Taber Instrument Corp., North Tonawanda, N. Y., has introduced the Thermocreaser to produce 90-deg. creases or folds on 5 to 20 pt. sheet plastics up to 30 in. in width. The machine is hand fed and foot operated, heat being supplied by a heated blade which is thermostatically controlled. The machine permits the choice of two creasing methods with the same unit, either folding on a metal die or a rubber pad. The machine plugs into an ordinary light socket and incorporates all necessary controls and gages.

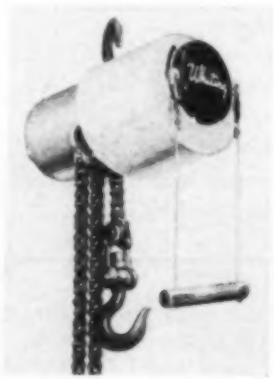
6. Check Valve

A UNIQUE double-seal check valve which is said to eliminate leakage and loss of pressure completely, even when the system contains grit, has been developed by Mansfield & Green, Cleveland, Ohio. Even with grit 0.01 in. in diameter, the valve is said to show no leakage at any pressure up to 10,000 psi. Construction is indicated in an accompanying view. The valve utilizes a metal-to-metal seat, plus a resilient rubber or synthetic rubber sealing ring on the check valve poppet. The line pressure forces the resilient ring against the metal seat with a force which increases as the pressure increases, resulting in greater sealing force at high pressures. Suitable for any fluid not destructive to rubber or synthetic rubber, the valve is made in sizes from ⅛ to 1 in. SPT for pressures to 10,000 psi.

7. Remote Instruments

TWO NEW pneumatic transmitting instruments have recently been announced by Taylor Instrument Cos., Rochester 1, N. Y. Shown in an accompanying illustration is the Model

New portable electric hoist

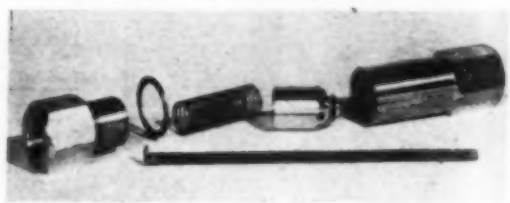


FOR MORE INFORMATION
See Reader Service Coupon on pages 183-184

226R transmitter intended for transferring a measurement of temperature, pressure, rate of flow or liquid level from the point of measurement to a central control panel. This transmitter is factory calibrated for accuracy to within ½ to 1 percent of scale range, assuring straightline relation between the pen or point of movement and the output air pressure. Only two adjust-

90-deg. creaser for thermoplastics

Disassembled view of check valve



8. BIG SPLASH IN NEWARK BAY

One hundred and sixty tons of steel, in a vessel 71 ft. long and 23 ft. inside diameter, makes a load too great for either rail or barge shipment. Shown here being launched in Newark, N. J., Bay, this vessel, fabricated by the M. W. Kellogg Co. at Jersey City, N. J., is being floated 2,000 miles by inland waterways to a Kellogg-engineered oil refinery installation in the Southwest. A recent issue of this company's magazine, "The Kellogram," dealt extensively with various phases of water, shipboard, barge and rail shipment

coolest customer an airliner ever had

Swordfish, strawberries, melons, and peaches are the passengers riding a new kind of airliner between Los Angeles and Chicago. To rush perishable foods between these great cities, Santa Fe Skyways built a flying icebox.

Cooled to 120 degrees below zero by dry ice, methyl alcohol circulates through the insulated cabin, keeping its unusual passengers in perfect shape throughout the trip.

Playing airline hostess to a swordfish is an unfamiliar role for methanol, which most people know best as the anti-freeze in their cars. This hard-working chemical is familiar to industry in a hundred everyday jobs. Methanol is a versatile solvent and an important ingredient in cleaning compounds, dyes, paint and varnish removers, plastics, and pharmaceuticals.

Both dry ice and methanol refrigerant for the first Skyway flight were furnished by Commercial Solvents. Commercial Solvents was the first company in the United States to market highly-refined synthetic methanol. It is one of more than two hundred fine CSC chemicals for industry, agriculture, and medicine.

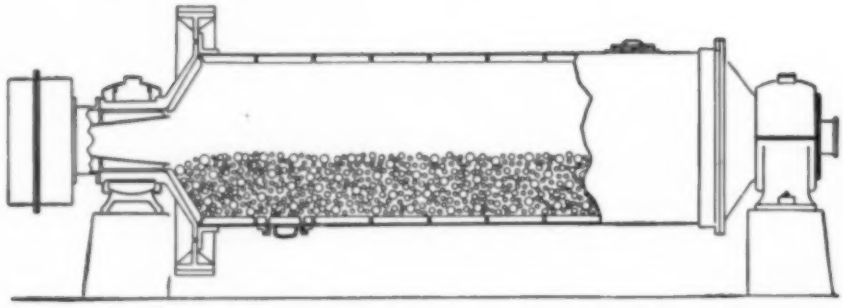
Commercial Solvents Corporation

17 EAST 42ND STREET, NEW YORK 17, N. Y.

For

"Straight-Through" Grinding...

HARDINGE TUBE MILLS



Where a finely-ground product is desired in a single pass of the mill—without the use of classifying equipment—Hardinge long Tube Mills fill the bill perfectly. Three types of Tube Mills provide a highly flexible line, especially adapted to the chemical process industries. They are:

1. PEBBLE TUBE MILLS—lined with flint, quartzite, or porcelain—with grinding pebbles of the same material. Used principally in metallurgical wet grinding, chemical processing of acid materials, and the dry grinding of ceramic materials—wherever metallic contamination must be avoided.

2. BALL TUBE MILLS—metal lined and charged with forged steel or cast iron balls—or even boiler punchings. They have greater capacity than the Pebble Tube Mills.

3. COMPARTMENT MILLS—with grates and partitions between compartments. Each compartment contains smaller balls to reduce the product progressively from stage to stage. Adapted for coarser feed than the straight Tube Mill.

In certain applications the Hardinge Tube Mill can also be effectively operated in closed circuit with a classifier. This arrangement has been found useful in the cyaniding of gold and silver ores (wet grinding) cement finishing (dry grinding) and other special processes.

Write for Bulletin 18-A.

HARDINGE

COMPANY INCORPORATED

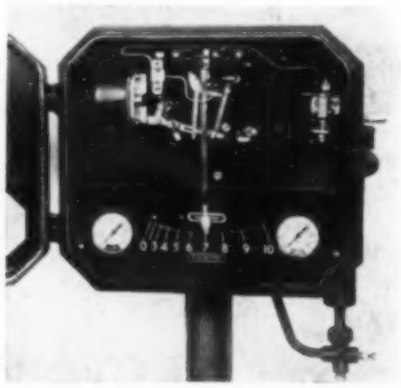
YORK, PENNSYLVANIA — 240 Arch St. • Main Office and Works

NEW YORK 17—122 E. 42nd St. • 205 W. Wacker Drive—CHICAGO 6

SAN FRANCISCO 5—94 Natoma St. • 200 Bay St.—TORONTO 1

ments, one for zero setting and one for instrument range are necessary. The instrument is available for single or double duty and is also available as a single-duty transmitter-controller, containing any of the five standard forms of this company's Fulscope control.

The second instrument is the Type 229RF liquid level transmitter designed particularly for use where non-



Pneumatic transmitter for process variables

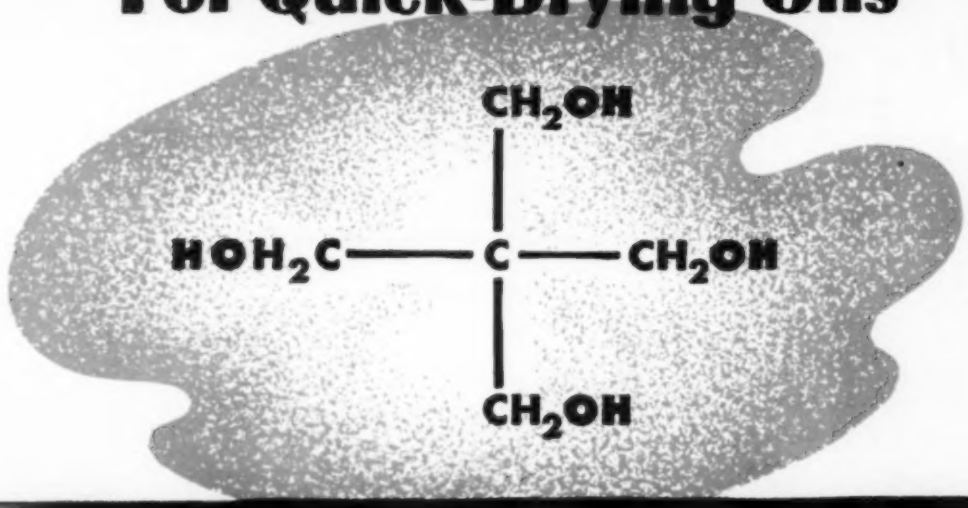
clogging or corrosion resistance is essential in measuring liquid levels or relatively low pressures of corrosive gases. The transmitter is of the force-balance type, employing a metal diaphragm in a stainless steel flange which is attached to the side or bottom of an open or vented tank. The air pressure transmitted is equal to the applied pressure or liquid head and has a range of 450 in. of water with an accuracy of plus or minus 1 in.

9. Electric Fork Truck

To take care of lower handling capacities of 1,000 and 2,000 lb. with a fork truck of relatively low weight, the Crescent Truck Co., Lebanon, Pa., has introduced two new models of its battery-operated Palletier, designated respectively as LGVH-1 and LGVH-2. The first of these weighs 2,500 lb. and the second 5,100 lb., with battery. Both are available with pneumatic tires as optional equipment and are provided with four speeds forward, and reverse, with two-handle operation. The seat is interlocked with a con-

Low-weight truck

For Quick-Drying Oils



PENTEK®

Pentaerythritol, Technical Grade

Pentaerythritol drying oils are noteworthy for

● Quick drying ● Quick bodying ● High gloss ● Water resistance ● Good aging qualities ● Hardness of film ● Toughness of film.

Pentek finds valuable application in coating compositions of alkyd, urea-formaldehyde, and modified phenolic resins . . . in plasticizers, emulsifying agents, and waxes . . . and as a glycerol replacement.

AVAILABILITY: 75-lb. multi-wall paper bags.

Technical literature will be sent upon request.

FINE HEYDEN CHEMICALS

HEYDEN CHEMICAL CORPORATION
393 Seventh Ave., New York 1, N. Y.
CHICAGO OFFICE, 20 North Wacker Drive
PHILADELPHIA OFFICE, 1700 Walnut Street

ANSUL SO_2 IN INDUSTRY

The versatility of Ansul Liquid Sulfur Dioxide in industrial practices is illustrated by the following examples:

ACIDITY . . . . . $SO_2 + H_2O \rightarrow H_2SO_3$

ANTICHLOR . . . . . $SO_2 + 2H_2O + Cl_2 \rightarrow H_2SO_4 + 2HCl$

ANTI-OXIDANT . . . $SO_2 + Na_2O_2 \rightarrow Na_2SO_4$

HYDROSULFITES . . . $2SO_2 + Zn \rightarrow ZnS_2O_4$

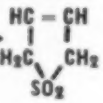
SULFOXYLATES . . . . $2SO_2 + 2Zn + 2CH_2O + H_2O \rightarrow (CH_2O \cdot HSO_2)_2\ Zn + ZnO$

NEUTRALIZATION . . $2SO_2 + 2NaOH \rightarrow 2NaHSO_3 \rightarrow Na_2S_2O_5 + H_2O$

SULFURYL CHLORIDE . $SO_2 + Cl_2 \rightarrow SO_2Cl_2$

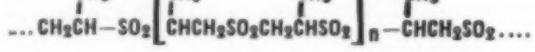
SULFITES . . . . . $SO_2 + H_2O + 2NH_3 \rightarrow (NH_4)_2\,SO_3$
$SO_2 + CaCO_3 + H_2O \rightarrow CaSO_3 + CO_2 + H_2O$
$SO_2 + Ca(OH)_2 \rightarrow CaSO_3 + H_2O$

THIOSULFATES . . . . $SO_2 + S + 2(NH_3) + H_2O \rightarrow (NH_4)_2S_2O_3$

SULFONES . . . . . $SO_2 + CH_2{=}CHCH{=}CH_2 \rightarrow$ 

GOLD RECOVERY . . $3SO_2 + (Au \cdot 2HCl \cdot 2HNO_3)\ (\text{aqua regia}) + 2H_2O \rightarrow Au + 2HCl + 3H_2SO_4 + 2NO$

CHROME TANNING . $3SO_2 + Na_2Cr_2O_7 \cdot 2H_2O \rightarrow 2Cr(OH)SO_4 + Na_2SO_4 + H_2O$

PLASTICS . . . . . $SO_2 + CH_3CH{=}CH_2 \rightarrow$ 

In addition Ansul Liquid Sulfur Dioxide is being currently used as a bleaching agent • purifier • preservative • solvent • fumigant • protective atmosphere in magnesium fabrication • refrigerant and in polymerization, etc.

Consult Ansul Technical Staff relative to the development of these and other applications for SO_2 in your processes.
Write for treatise on Liquid Sulfur Dioxide and request bulletins describing the specific application in which you are interested.

PHYSICAL PROPERTIES

Chemical formula	SO_2
Molecular weight	64.06
Color (gas and liquid)	Colorless
Odor	Characteristic, pungent
Melting point	−103.9° F. (−75.5° C.)
Boiling point	14.0° F. (−10.0° C.)
Density of liquid at 80° F.	(85.03 lbs. per cu. ft.)
Specific gravity at 80° F.	1.363
Density of gas at 0° C. and 760 mm.	2.9267 grams per liter (0.1827 lb. per cu. ft.)
Critical temperature	314.82° F. (157.12° C.)
Critical pressure	1141.5 lbs. per sq. in. abs.
Solubility	Soluble in water
Purity	99.9+% (by wt.) SO_2 (H_2O less than 0.01%)

*REG. U.S. PAT. OFF.

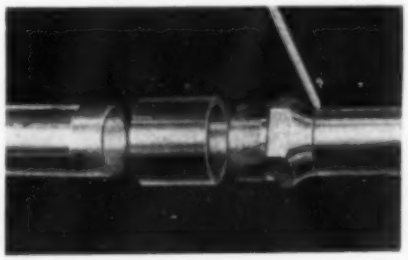
For your METHYL CHLORIDE *applications . . . . Use* ANSUL METHYL CHLORIDE

ANSUL CHEMICAL COMPANY
INDUSTRIAL CHEMICALS DIVISION, MARINETTE, WIS.
Eastern Office: 60 E. 42nd St., New York City

trol circuit so that the handle must be returned to neutral if the current is interrupted by the operator's leaving his seat. Both models are provided with the usual safety features available on larger trucks, as well as with the usual hoist, tilt and steering arrangements.

10. Stainless Tubing Adapter

To PERMIT thin-walled stainless steel tubing to be used in the same piping installations with standard I.P.S. stainless pipe, a new stainless adapter fitting has been developed and

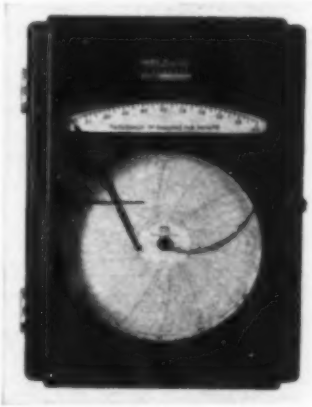


Adapter fitting for thin-walled stainless tubing

announced by the Electric Steel Foundry, 2141 N.W. 25th Ave., Portland 10, Ore. As appears from the accompanying illustration the Esco P-T adapter, which is provided with standard pipe threads, is permanently butt-welded to the tubing which can thus be assembled the same as pipe.

11. Remote Indicator-Recorder

ELECTRICAL impulses over a two-wire circuit are used to operate a new secondary instrument for recording, indicating, and totalizing that has been announced by Builders-Provi-



Recording-indicating flow totalizer

dence, Inc., Providence, R. I. The instrument, which is suitable for use with a variety of primary devices such as mechanical flow meters, can provide readings of total flow, rate of flow, and a record of flow rate over any distance from a few feet to many miles from

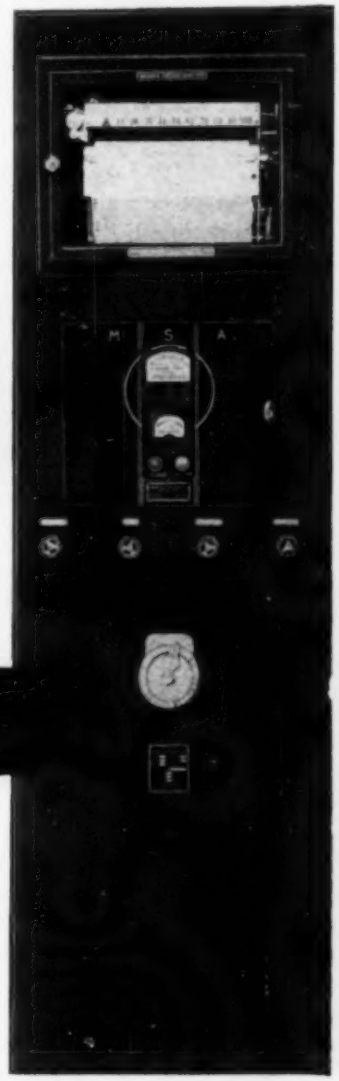
M·S·A

INERT GAS ANALYZER, RECORDER AND CONTROLLER

This Instrument maintains a continuous analysis of the combustible components of an inert gas, and records the gas composition in percentage of combustibles. It may be employed for the control of inert atmospheres used in heat treating, chemical and oil refining processes, automatically adjusting the fuel-air ratio to hold the product within very narrow limits. Available with calibration for any range between 0 to 1% combustibles, and 0 to 10% combustibles, each M.S.A. Inert Gas Analyzer, Recorder and Controller is custom-built for its specific application. *Write for details.*

M·S·A Recording Instruments

FOR AIR AND GAS ANALYSIS



M·S·A

OXYGEN INDICATOR AND RECORDER

With many uses in industry, this Instrument provides maximum usefulness and precision in measuring the oxygen content of atmospheres, both inert and combustible, in chemical, metallurgical and petroleum applications. Through the measurement of oxygen content of fuel gases the Instrument improves safety in utility operations and aids in the control of pipeline corrosion. Through its measurement of combustion efficiency, the Indicator will point the way to substantial fuel economy in large industrial installations. Designed for permanent installation and continuous operation, the M.S.A. Oxygen Indicator and Recorder is available in the following standard ranges: 0 to 0.5%, 0 to 5.0%, 0 to 10%, and 0 to 25% oxygen. *Request Bulletin DW-3.*

Your inquiries are invited on our other standard and special instruments for gas analysis.

M·S·A

CARBON MONOXIDE RECORDER

A modern, highly developed instrument, bringing extreme sensitivity and precision to the continuous testing of atmospheres and gases for carbon monoxide content—serving as a safeguard of life and health, and as a scientific check on industrial operations and processes. For maximum sensitivity the Recorder can be calibrated for a range of 0 to 500 parts of CO per million of air, and where wider range is desired, from 0 to 2000 parts per million. *Write for details.*

MINE SAFETY APPLIANCES COMPANY

BRADDOCK, THOMAS AND MEADE STREETS · PITTSBURGH 8, PA.

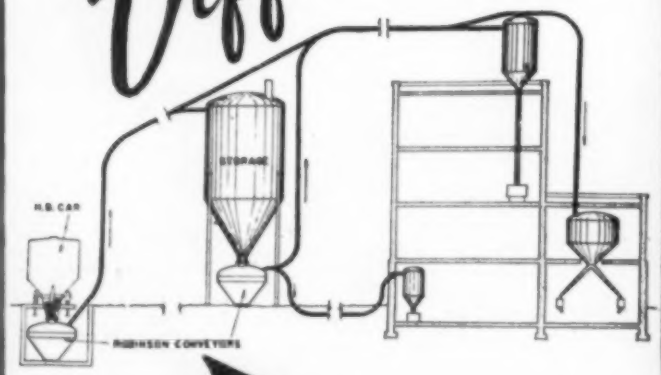
District Representatives in Principal Cities

In Canada: MINE SAFETY APPLIANCES COMPANY OF CANADA LIMITED, TORONTO

MONTREAL · VANCOUVER · CALGARY · WINNIPEG · NEW GLASGOW, N. S.

ROBINSON *Air-Activated* CONVEYOR

THE PNEUMATIC CONVEYOR THAT'S *Different*



"*Floating*" Material Through a Pipe is Better Than Blasting It Through

"*Floating*" It Through May Be Better Than Handling It Mechanically

WE are referring to the handling of dry, finely granular or pulverized materials in bulk into, through or out of the plant.

We are also referring to the unique way the material in the Robinson System is "fluffed" up into a cloud and then quickly conveyed through piping to its destination. The action might be likened to the flow of a liquid through a pipe. It's unique in pneumatic conveying methods.

Not only is the Robinson Air-Activated System already in use in many processing plants but within the past year it has been installed or ordered for handling such products as: litharge, borax, silica, soda ash, cement, carbon black, ammonium nitrate, limestone, starch, water softening chemicals.

Industry is finding out more and more about the Robinson Method for handling fine, dry, granular or pulverized materials in bulk. After investigating thoroughly many companies are ordering the system.

We'll be glad to hear about your handling problem and if there is any doubt, we'll be glad to make a pilot plant test.

ROBINSON *Air-Activated* Conveyor Systems

***Division of* MORSE BOULGER DESTRUCTOR CO.**

211-A East 42nd Street **New York 17, N. Y.**

Representatives in Principal Cities

FOR MORE INFORMATION
See Reader Service Coupon on pages 183-184

the primary instrument. The transmitter switch, which is driven by the primary meter, requires no separate power source.

12. Pneumatic Transmitter

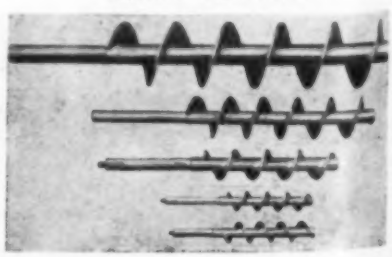
FOR APPLICATIONS involving long lead lines between transmitter and control panel, particularly where compactness of the control panel is a consideration, Taylor Instrument Cos., Rochester, N. Y., have announced the Transet controller. This device regulates the control valve and also transmits air pressure proportional to the pen movement to an indicating receiver remotely located on a panel board. The panel board contains two gages calibrated in the same unts as the controller chart, one showing the controlled variable, the other showing the set pointer position. When both pointers coincide, the pen and set pointer of the controller itself will be together and the process will be under control. The panel also includes a handwheel for remotely adjusting the set point of the controller to any desired value. The panel or receiver unit, shown in an accompanying illustration, is so compact that seven such units are said to take up no more space than two conventional recording receiver-controllers.

Pneumatic transmission receiver unit

13. Conveyor Screws

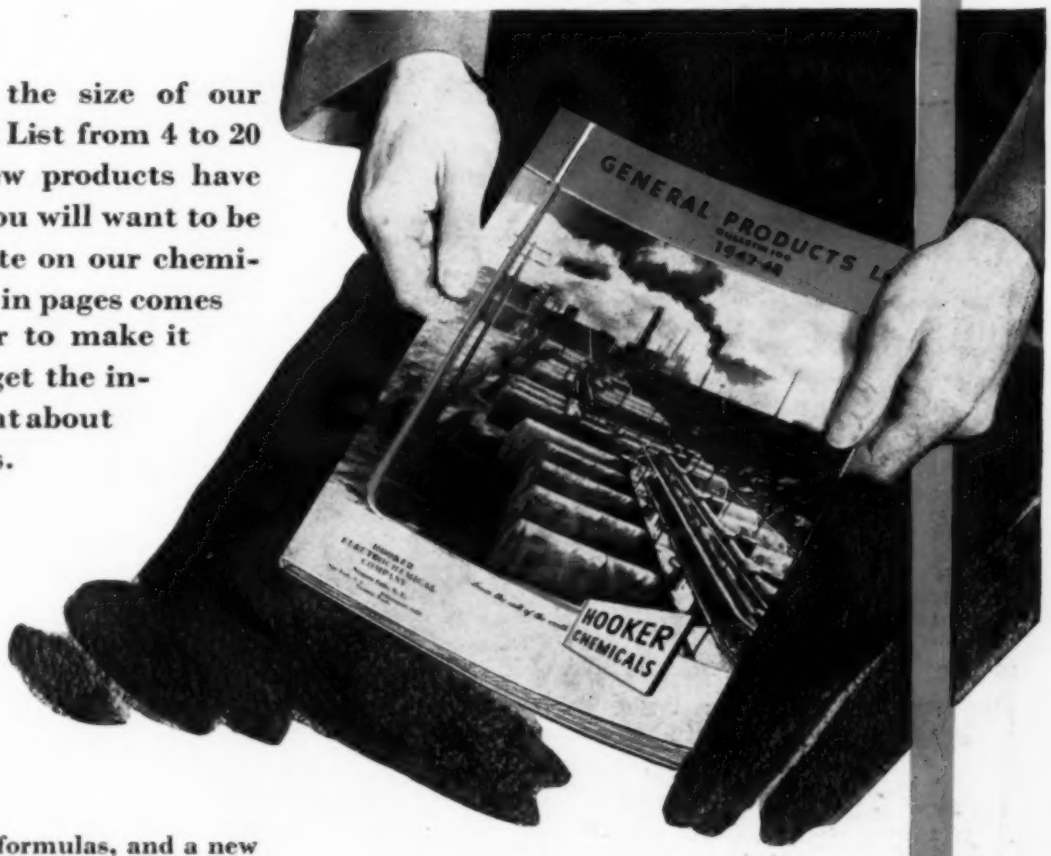
NEW TECHNIQUES in manufacture are employed in making the screw conveyors announced under the trade

Typical conveyor screws



Get the Facts on Hooker Chemicals from our New General Products List

We've increased the size of our General Products List from 4 to 20 pages. Several new products have been added and you will want to be brought up to date on our chemicals. The increase in pages comes from an endeavor to make it easier for you to get the information you want about Hooker Chemicals.



Larger type, graphic formulas, and a new format facilitate your finding the chemicals in which you are interested. Included are description, principal physical and chemical properties, uses, and shipping containers. This new products list also describes briefly the various chemical processes and facilities which Hooker has available for industry.

You who are not yet acquainted with Hooker Chemicals will find this new Products List an excellent introduction to a source for industrial chemicals of high purity; it will also pay you to refer to this Bulletin whenever you need chemicals. Feel free, too, to call on Hooker's Technical Staff for advice and help on the application of Hooker Chemicals to your problems.

The words "Bulletin 100" on your business letterhead will bring you a copy of the Hooker General Products List.

HOOKER ELECTROCHEMICAL COMPANY

5 Forty-Seventh Street, Niagara Falls, N. Y.

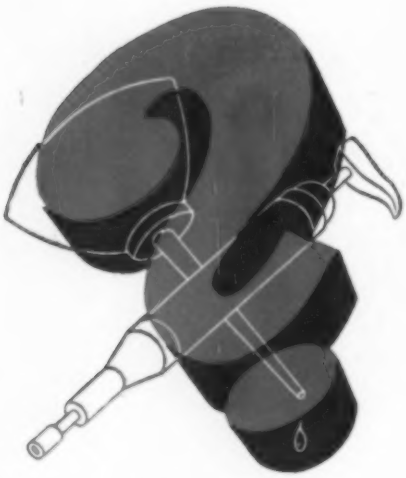
New York, N. Y. Wilmington, Calif.

Tacoma, Wash.

HOOKER CHEMICALS

From the salt of the earth

Caustic Soda	**Muriatic Acid**	**Sodium Sulfide**
Paradichlorbenzene	**Chlorine**	**Sodium Sulfhydrate**



GREASE OR OIL

The question of selection of the proper type and consistency of lubricants need offer no problem. LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest grease types. All reduce friction and wear, protect against rust and corrosion, and are more economical than conventional lubricants. Let us prove our case.

℞ FOR YOUR MACHINERY

No. 2 — Ideal for general all type lubrication, ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8 — Because of high film strength and long life it reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107 — One of the most popular grease type products for general application by pressure gun or cups.

No. 70 — For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA — Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING — This is the LUBRIPLATE Lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

LUBRIPLATE

FISKE BROTHERS REFINING CO.

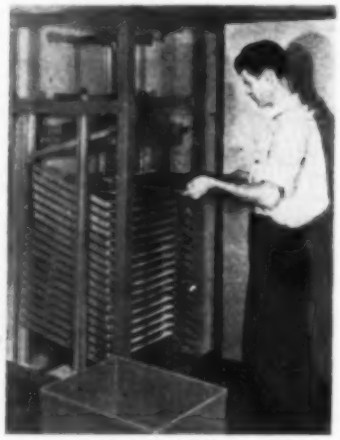
NEWARK 5, N. J. TOLEDO 2, OHIO

DEALERS FROM COAST TO COAST
CONSULT YOUR CLASSIFIED TELEPHONE BOOK

name of Murco by D. J. Murray Mfg. Co., Wausau, Wis. The conveyor elements are of continuous one-piece construction, welded, not cast. They are made without laps or rivets and because of the elimination of joints, each section of the conveyor is said to be stronger and longer lasting, especially in severe service. These conveyors are made of stainless steel and other suitable metals in a range of diameters, lengths and pitches, according to customers' specifications.

14. Vertical Stack Filter

To REDUCE operating expense by facilitating cleaning, the Youngstown Miller Co., a subsidiary of Walter Kidde & Co., Belleville, N. J., has introduced a new vertical stack filter press of unique construction. The unit employs cast iron elements which combine plate and frame in one casting,



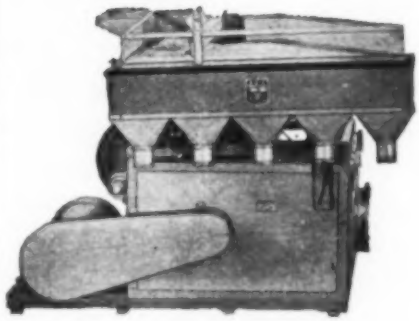
Vertical stack filter press

mounted in a vertical arrangement within a structural steel framework which provides an individual latching arrangement for each frame. Starting with the top frame, each section is individually latched in an elevated position to permit the filter paper and cake to be pulled forward out of the press. Thus the cake is quickly removed and the filter paper replaced. Frames are then re-lowered into position and tightened by a hand screw to form a tight press. The filter area is 31 sq. ft. and the cake space 2 cu. ft. The new press is said to be suitable for filtering many liquids, including alkyd resins, solvents, paints and varnishes, liquid soaps, and animal and vegetable oils.

15. Air Filter

DESIGNED primarily to remove oil fog from instrument air supply lines, a new filter dripwell has been introduced by Moore Products Co., H and Lycoming Sts., Philadelphia 24, Pa. The filtering material is contained in

AIR TABLING can improve your Ore-Dressing



Air Tabling can be used either independently or in conjunction with other separation processes to give improved effectiveness of ore dressing.

On jig or wet table concentrates, Air Tabling can make a very sensitive further separation.

Air Tabling can be used as a rougher or as a finisher—either before or after other processes.

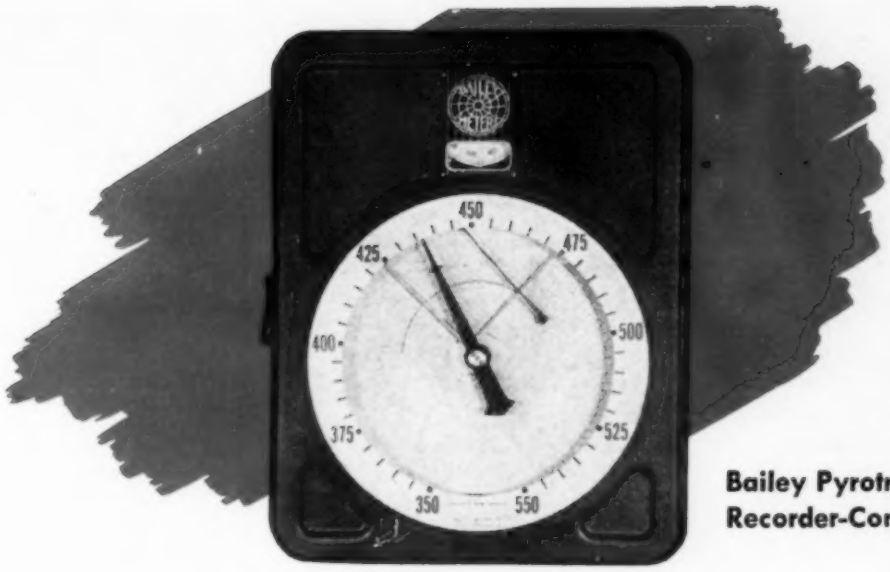
In flotation, fine grinding is the most important part of milling cost. Therefore, if a clean tailing can be made at coarser screen size, less fine grinding is needed prior to flotation.

Cost per ton of installing Air Tabling is roughly 60% of the cost of any other type of equipment.

• Our engineers will be glad to help solve your separating or concentrating problems and submit recommendations. Send sample for laboratory tests.

SUTTON, STEELE & STEELE, INC.
DALLAS, TEXAS
SALES OFFICES
SEPARATIONS ENGINEERING CORPORATION
110 EAST 42nd STREET, NEW YORK, N. Y.
OLIVER BUILDING, PITTSBURGH, PENNSYLVANIA
ENGINEERING BUILDING, CHICAGO, ILLINOIS
FLOUR EXCHANGE BUILDING
MINNEAPOLIS, MINNESOTA
41-43 DRUMM STREET
SAN FRANCISCO, CALIFORNIA

S S S PROCESS FOR BETTER PRODUCTS—FASTER



Bailey Pyrotron Recorder-Controller

Looking for Better Temperature Instruments?

. . . Then check these features of Pyrotron Electronic Resistance Thermometers . . .

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the Bureau of Standards in establishing basic standards for temperatures from —190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between —100°F and 1200°F, ask for Bulletin No. 230-A. P-9

BAILEY METER COMPANY

1054 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE	FLOW
PRESSURE	LEVEL
% OXYGEN	DENSITY
% COMBUSTIBLES	RATIO

HIGHER CAPACITY... BETTER PRODUCTION in a fraction of the space!

GRINDING
EMULSIFYING
HOMOGENIZING
MIXING
DISPERSING
DISINTEGRATING

MOREHOUSE HY-R-SPEED MILL

Model SB1400

Requiring only a fraction of the space needed for ordinary mills, the new Model Morehouse SB1400 Mill produces four times as much—*better and more efficiently*. This outstanding performance has been proven on a wide variety of materials—both wet and dry—in chemical and general industrial fields.

The unit is portable, requiring no special foundation. Modern design and scientific engineering result in smooth operation—noise and vibration are negligible. Equipped with vertical shaft type motor, and efficient cooling and fume-collecting features, it is economical and dependable. Priced far below ordinary mills, the Morehouse Hy-R-Speed Model SB1400 will save you substantial amounts both in first cost and in operation. Write today for full information.

MOREHOUSE INDUSTRIES
1156 San Fernando Rd.,
Los Angeles 31, Calif.
Since 1898

an open end brass cylinder which is mounted in a brass housing. Air enters the top of the inner cylinder, passes down through the filtering material and up between the cylinder and housing. Trapped oil and moisture are retained in a bottom chamber until

Instrument air filter

blown off. The steady "blow-down" action of the air is said to clean the filter material continually. In a 100-hour test of this filter, it is claimed to have trapped 92 percent of a known quantity of oil vaporized into the air, compared with 9 to 59 percent for conventional filters.

6. Double-Ribbon Mixer

AFTER REDESIGN, Mixers, Inc., Wensley and Allen Sts., Philadelphia 34, Pa., has announced an improved line of mixers based on several types formerly made by the Hottmann Machine Co., Philadelphia. Produced from welded steel with direct connected flat or V-belt drives, these mixers employ a safety chamber to prevent contamination of the product and avoid material working into the gear box, while jacketing for temperature control and vacuum operation can be

Twin-screw ribbon type mixer

the

State of Missouri offers a premium in Industrial Opportunities!

As the home of some of the larger chemical industries in the nation, Missouri is already well established as a leader in the field. You, too, should investigate the possibilities of locating your plant or branch in this center of one of the country's richest markets.

Transportation facilities to every section of the country are unexcelled. Raw materials are close at hand. Missouri offers a new, modern state constitution which is favorable to industry, low taxes, skilled and semi-skilled labor, adequate water supply, good power facilities, and 350 communities eager to offer their cooperation.

Specialized, confidential service to Industrialists. Write direct: Missouri State Division of Resources and Development, Jefferson City, Missouri, Dept. T-55.

(70)

MISSOURI
the Heart of America

LOOKING INTO YOUR FUTURE...

The fountainhead of knowledge is research. So today, people in our laboratories are looking into the future, searching constantly for new ways to bring you more and better chemical products. It is our goal to bring to industry an ever-increasing range and volume of industrial chemicals for the manufacture of more and better products.

In the future, as in the past, you can rely on ORONITE CHEMICALS to provide the materials for wider industrial horizons.

ORONITE

CHEMICALS

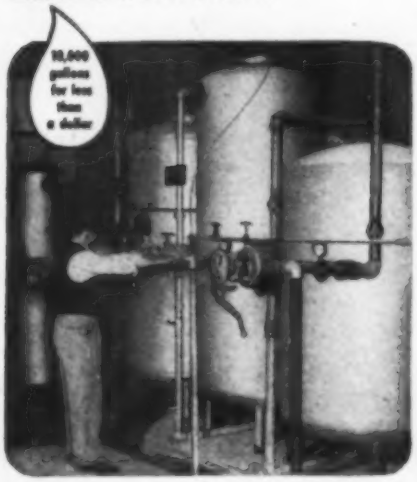
REG. U. S. PAT. OFF.

ORONITE CHEMICAL COMPANY

200 Bush Street, San Francisco 4, Calif • 30 Rockefeller Plaza, New York 20
Standard Oil Building, Los Angeles 15, California

De-ionized Water

...provides all the advantages of distilled water at a fraction of distilled water's cost!



ANOTHER ILLCO-WAY INSTALLATION: Pure water is produced by this compact ILLCO-WAY De-ionizer (flow rate: 900 gph) at American Central Division—Avco Mfg. Corporation, Connersville, Indiana. No fuel, no cooling water required.

If your manufacturing process could be improved by pure water, but the cost of *distilled water* is prohibitive—modern ILLCO-WAY De-ionizers are the solution!

You can obtain pure water—in volumes up to 500,000 gallons an hour—*at 1% to 10% of the cost of distillation!*

Hundreds of pharmaceutical, ceramic, cosmetic and other industries are obtaining pure water from compact ILLCO-WAY equipment such as illustrated above. Units are specially engineered to meet your needs. *Write for latest literature.*

ILLINOIS WATER TREATMENT CO.
844-5 Cedar Street, Rockford, Illinois
7310-85 Empire State Bldg., New York City

TESTED IN THE LABORATORY · ILLCO-WAY · PROVED IN THE FIELD

Ion-exchange Engineering

Treatment of Sugar, Liquid Sugars, etc., Purification of Industrial Wastes; Treatment of Boiler Feed-Water; Purification of Process Water; Reclamation of Valuable Constituents

supplied. The three types include the Kutmixer, used largely in the food field, which consists of a double-ribbon mixer combined with a rotary cutting unit; the Twin-Screw mixer, shown in the accompanying illustration, which is similar to the first, except paddles are substituted for the cutting unit; and the Triplex mixer, a jacketed and inclosed type for extremely heavy product mixing in which a variety of types of paddles and screws on three parallel shafts are provided.

Equipment Briefs

17. POLYVINYL chloride-acetate sheeting is employed by West Disinfecting Co., 42-16 West St., Long Island City 1, N. Y., in manufacturing the company's new Durma-Gard apron for protection against acids, alkalis, greases, oils and other occupational hazards. The new apron is put together with heat-sealed seams and especially reinforced stress points. At the bottom it has a specially constructed trough to catch drippings which would otherwise fall on shoes and clothing. Its weight is only 10 oz.

18. PROTECTION against explosions caused by flame failure in industrial oil burner installations is accomplished by the new Fircye photoelectric flame failure safeguard made by Combustion Control Corp., 77 Broadway, Cambridge 42, Mass. The device employs a photoelectric scanner combined with a programming control. The scanner contains both the phototube and amplifier tube. Immediately after flame failure, the device turns off the fuel supply and the burner. Accurate setting of the programming control is possible, both for the oil valve delay and the post ignition period. Timing is accomplished by means of a synchronous motor.

19. A POSITIVE rotary pump weighing only 5 lb., which has a capacity of 2.5 g.p.m. and can pump against pressures up to 1,000 psi., or pull a vacuum of 26 in., has been developed and put on the market by the Ellipse Corp., Pump Division, 24 South Clinton St., Chicago 6, Ill. Pumps of similar capacity, but for 2,500 and 3,500 psi., are also available. The pump is said to be of high efficiency, extremely quiet in operation, vibrationless and non-pulsating. It is claimed that it can be used to pump practically any substance from

FOR MORE INFORMATION
See Reader Service
Coupon on pages 157-158

CASE HISTORY No. 15
One in a series of factual experiences of a group of American manufacturers with Multiwall Paper Bags.

COST COMPARISON
(Per Ton)

	200-lb. barrels	75-lb. paper bags
Container cost	$16.50	$ 4.07
Labor cost	2.60	1.30
Total bag and labor cost	$19.10	$ 5.37
Saving per ton paper over barrels		$13.73

CLASS OF PRODUCT PACKED

CEMENT	FERTILIZER
CHEMICALS ✓	FOOD
FEEDSTUFFS	MISCELLANEOUS

PRODUCT CHARACTERISTICS

ABRASIVE	GRANULAR ✓
CORROSIVE	HEAVY
DELIQUESCENT	HYGROSCOPIC
DUSTY	LIGHT
FREE-FLOWING ✓	VISCOUS

ST. REGIS PACKAGING SYSTEMS are designed to meet a wide range of product requirements and plant layouts. Packers are available in a variety of sizes and types, with filling speeds as high as twenty-four 100-lb. bags per minute—with one operator. Nearly 400 commodities—rock products, fertilizers, chemicals, foods, and feeds—are now being packaged in sturdy, low-cost multiwall paper bags.

ALCOHOL *packed in Multiwall paper bags*

. . . with a triple saving for the Heyden Chemical Corporation

A recent addition to the growing list of products packaged in multiwall paper bags is Pentek — a powdered alcohol manufactured at the Garfield, N. J., plant of the Heyden Chemical Corporation.

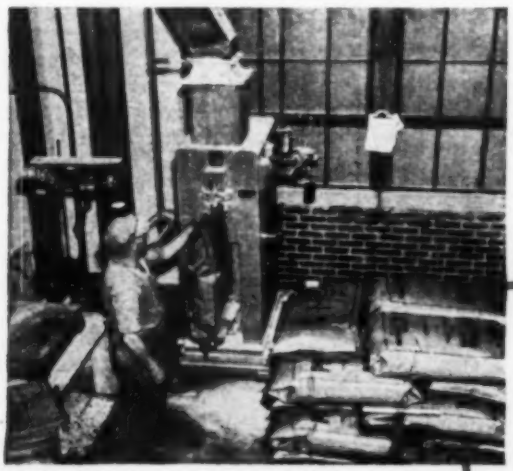
This chemical formerly was packed in 200-lb. wooden barrels. But these containers were costly, difficult to handle, and according to company officials "ate up too much valuable storage space." In addition, the filling operation was inefficient, dusty, and expensive.

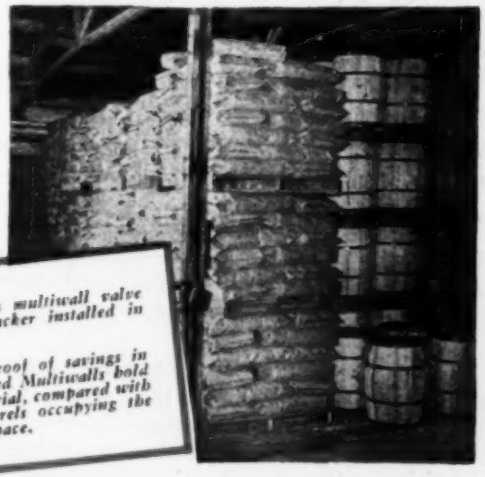
To overcome these objections, in 1946 the company installed a St. Regis automatic bag filling machine and switched to multiwall paper valve bags. These five-ply containers are made with an asphalt-laminated sheet to protect the product against moisture, and a tuck-in sleeve valve for added protection against contamination. The results of this new packaging system? These impressive three-way savings:

- ***Container costs dropped 75%***
- ***Labor costs dropped 50%***
- ***Savings in storage space totalled almost 50%***

But that's not the whole story . . . customers like Multiwalls because they save storage space and reduce handling time and labor. Plant officials are enthusiastic about Multiwalls' eye-appeal which resulted from colorful bag printing. Plant workers find Multiwalls easy to handle and praise the elimination of dust from the packaging operation.

Mail the coupon for an illustrated folder giving full details. Learn how a St. Regis Packaging System can improve your packaging operation.





Left: *One man fills multiwall valve bags on 100-LS packer installed in Heyden plant.*

Right: *Dramatic proof of savings in space . . . palletized Multiwalls hold 27,000 lbs. of material, compared with 16,000 lbs. in barrels occupying the same amount of space.*

MULTIWALL

ST. REGIS SALES CORPORATION

(Sales Subsidiary of St. Regis Paper Company)

NEW YORK 17: 230 Park Ave. CHICAGO 1: 230 No. Michigan Ave.

BALTIMORE 2: 1925 O'Sullivan Bldg. SAN FRANCISCO 4: 1 Montgomery St.

ALLENTOWN, PA.: 642 Hamilton St.

Mail this coupon for the complete story

OFFICES IN OTHER PRINCIPAL CITIES — IN CANADA: ST. REGIS PAPER CO. (CAN.) LTD., MONTREAL, VANCOUVER

ST. REGIS SALES CORPORATION
Dept. CE, 230 Park Avenue, New York 17, N. Y.

Without obligation, please send me full details regarding "Case History" No. 15, outlined above.

NAME_____

COMPANY_____

ADDRESS_____

"For a fire in here, the extinguishing agent must be non-damaging"

If a blaze breaks out in your correspondence files—or blueprint storage room—*putting out* the fire can cause more damage than the fire itself. But not if your extinguishing system has been recommended by a Kidde representative!

In a *Kidde* System for record vault protection, clean, safe carbon dioxide fills the threatened space, to kill flames fast . . . keeping fire damage to a minimum. And that's the *only* damage there is! There's no water-soaking of valuable papers—no chemical attack on them.

Fast, sure, non-damaging . . . *Kidde* equipment offers these same advantages against the tough fires that break out in flammable liquids and electrical equipment. While you're talking to the Kidde representative about record vault protection, ask his advice about safeguarding these other hazards too.

Walter Kidde & Company, Inc., 528 Main Street, Belleville 9, N. J.

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

FIRE PROTECTION HEADQUARTERS

heavy lubricants to boiling water and light gases. Displacement is accomplished by mechanical action of vanes and a rotor turning about a constant center. Inlet and outlet are tapped for ½ in. standard pipe.

20. Industrial finger injuries resulting from the wearing of rings are said to be surprisingly frequent, often resulting in a difficult operation of removing a badly bent ring before surgical repairs can be made or first-aid dressings applied. Industrial Products Co., 2820 North 4th St., Philadelphia 33, Pa., is now offering a new finger ring cutter designed for quickly cutting the ring from the injured member. Eliminating the need for filing, the device employs a manually operated rotary saw which quickly cuts through rings of all common metals including Monel and stainless steel.

21. Alternating or direct current voltages from 65 to 660 may be quickly and easily determined with a midget neon-glow meter of moderate cost introduced under the name of Mini-Volt by Industrial Devices, Inc., 22 State Road, Edgewater, N. J. The device is operated merely by turning a knob until the neon glow is extinguished, whereupon the voltage is read directly from the scale. Multiplication of the reading by 1.15 is necessary for direct current. The meter can be used not only to determine what voltage a line is carrying, but also to indicate blown fuses and to check overloaded lines by taking readings at various points with the load on.

22. All light-duty V-belts produced by the B. F. Goodrich Co., Akron, Ohio, are now constructed with the parallel groupings of cords used as the tension members made of rayon. Compared with the cotton previously used, the new rayon construction is said to give longer belt life, particularly at elevated temperatures. This increase in life, according to accelerated laboratory tests, is at least 50 percent. The belt has a smaller permanent stretch and yet a higher temporary elongation of the rayon cord during a change in tension so that it is claimed that such belts are able to carry maximum loads much longer than those made with cotton.

23. Announced recently, the Airco No. 375 electrode for producing machinable welds on cast iron, is now available from Air Reduction Sales Co., 60 East 42nd St., New York 17, N. Y. This electrode has a high nickel core wire and a heavy extruded coating. It is stated that preheating is ordinarily not necessary in cast iron welds when this rod is used.

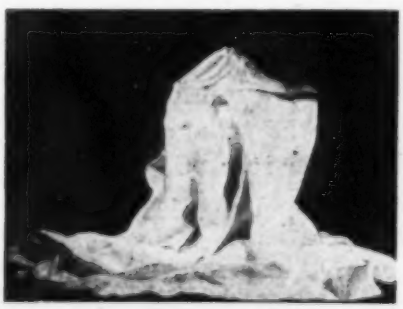
NEW PRODUCTS AND MATERIALS

Richard W. Porter, ASSISTANT EDITOR

51. Protective Coatings

NEW protective coatings have been announced by the Merchants Chemical Co., Elm Court, Stamford, Conn. The first of these is a corrosion resistant coating called Dy-Nes-Co formulated from natural and synthetic resins in a hydro carbon vehicle. It is said to be useful in protecting plant equipment, structural steel, piping, stacks, etc. against corrosive action of acids, acid fumes, alkalis and atmospheric conditions. It may be applied by spray or brush, but it is necessary to clean the surface thoroughly before application. Sand blasting is preferred. It is satisfactory for use where air temperatures do not exceed 550 deg. F. and where water immersion temperature does not exceed 180 deg. F. The second of these coatings is known as Dyna-Clad 1060, the thermoplastic coating for use on metals, brick, concrete and other similar surfaces. This material forms a flexible waterproof film which is claimed to be immune to most acids, alkalis, oils, petroleum derivatives, alcohols and salt water. It requires no primer and may be easily applied by spray or brush. 300 to 350 sq. ft. per gal. coverage for a 0.001 in. coating thickness is obtained. While Dyna-Clad 1060 is an air dry coating, drying can be speeded up by baking at 275 deg. F. for a 10 min. period. The third of these coatings is known as Dyna-Flex 20-20. It is a plastic, strip-film coating, composed of a solution of synthetic resins in organic solvents. This is used in the protection of equipment, machine parts, precision tools, etc. It is effective in protecting aluminum and manganese against atmospheric and air corrosion and is applied cold by spraying at normal temperatures. It air dries in a few minutes and can be stripped if desired 12 to 24 hours after application.

52. A high-temperature insulating material developed during the war for use on jet aircraft engines by the H. I. Thompson Co., 1733 Cordova St., Los Angeles, Calif., is now available in other useful forms. At the left is shown a completely prefabricated Rafrasil blanket supplied for insulation for the Lockheed P-30 jet tailpipe. At the lower right is shown Rafrasil in batt form which is supplied in rolls approximately 14 ft. long by 3½ ft. wide by 3/16 in. average thickness. At the upper right is shown Rafrasil cloth supplied in rolls 32 in. wide and a variety of lengths. The thickness of this cloth is approximately 0.015 in. It is also available as tape and cord. Rafrasil, a fibrous material, is composed essentially of pure silica and will withstand continuous temperatures of 2,000 deg. F.



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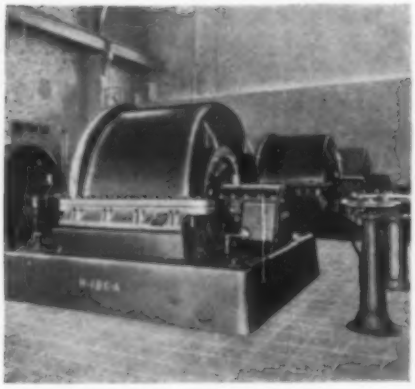
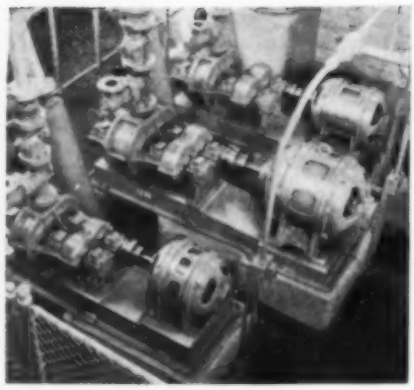
53. Refractory Concrete

HAVING the ability to withstand temperatures as high as 3,000 deg. F., a new concrete has been developed by the Babcock & Wilcox Co., 85 Liberty St., New York 6, N. Y. Known as B & W Kaocast, the product is being placed on the market after a period of successful service trials under various conditions. This material is said to fill a need for a refractory castable in the construction of industrial furnaces operating at temperatures ranging from the top limit of standard refractory castables up to as high as 3,000 deg. F. Both in service trials and in laboratory tests, this material has shown good stability and resistance to disintegration (spalling) under repeated heating and cooling cycles. Its durability is said to be enhanced by the small volume change on initial firing and its lack of shrinkage or expansion under continuous use of high temperatures. Because it can be poured into place like ordinary concrete, Kaocast should be use-

FOR MORE INFORMATION
See Reader Service Coupon on pages 183-184





Safe, clean water usually depends upon the protection of supply sources through sewage purification. Many modern plants use Roots-Connersville Blowers to help remove impurities and thus allow the resultant purified water to be returned to lakes and streams for re-use by homes and industries.

The same R-C *dual-ability* which devises these essential blowers is responsible for the successful, dependable performance of man-made "wind-makers" in practically every industry and in a wide variety of applications. Our capacity to supply either Centrifugal or Rotary Positive types enables us to meet the exact needs of each installation, without prejudice.

Advanced engineering, plus almost a century of blower building experience, enhances the value of this completely independent thinking. The result is that R-C Blowers fit the job and can be relied upon for many years of economical, trouble-free operation.

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705 Illinois Ave., Connersville, Indiana

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ROTARY CENTRIFUGAL
BLOWER BUILDERS R-C SINCE 1854
BLOWERS · EXHAUSTERS · BOOSTERS · LIQUID AND VACUUM PUMPS · METERS · INERT GAS GENERATORS

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ful in furnace construction where it can be used in place of special shapes made of kiln-fired materials. It should be useful as a furnace maintenance material.

54. Emulsion-Type Detergent

A SOLVENT emulsion-type detergent known as Emlon has been recently announced by the Wyandotte Chemical Corp., Wyandotte, Mich. This product is a combination of organic solvents and emulsifiers which aid the formation of stable emulsions in the presence of acids, alkalis, and other electrolytes. Tests have shown this material to be effective and economical in a wide variety of applications as follows: in power spray washers, presoak and still tanks, for cleaning prior to phosphatization, and as an adjunct to acid or alkali cleaners. It can be safely used on ferrous as well as nonferrous surfaces. It is available in 5 gal. and 15 gal. containers and 55 gal. drums.

55. Cleaning Compounds

Two new dipping compounds have recently been announced by Turco Products, Inc., 6135 South Central Ave., Los Angeles 1, Calif. The first of these is a non-flammable fast-acting liquid paint dip marketed under the name of Paint-Zip, which is said to

56. Steel wire is used in this experimental tire developed by United States Rubber Co., Rockefeller Center, New York, N. Y., for use on heavy trucks; strength of the steel makes tire more resistant to blowouts, while use of fewer plies results in a cooler running carcass.

General Chemical Research Presents

BASIC CHEMICALS

GENERAL CHEMICAL COMPANY

Sulfan*

Brands of STABILIZED SULFURIC ANHYDRIDE

General Chemical Company—America's pioneer with the Contact Process for manufacture of high strength sulfuric acid and oleum—makes another major contribution to Basic Chemicals for American Industry with SULFAN . . . Anhydride of Sulfuric Acid.

By perfecting new methods of stabilizing Sulfur Trioxide, General Chemical Research takes an invaluable chemical tool off the shelf of laboratory curiosities and brings it to the Process Industries as a chemical of commerce for use in a host of ways.

General Chemical offers SULFAN in three chemically equivalent forms:

Sulfan 'A' Partially Stabilized, melting at approx. 35°C;

Sulfan 'B' Completely Stabilized, melting at approx. 17°C; and

Sulfan 'C' Unstabilized.

Experimental samples and further technical information are available on request from General Chemical Company, Research and Development Division, 40 Rector Street, New York 6, N. Y.

Some Potential Uses

1. For fortification of spent oleum, making possible a ready supply of any strength oleum.
2. In benzenoid sulfonations for elimination of mixed sulfonates: meta- only or ortho- and para- derivatives only are formed.
3. For di- and poly-sulfonations of aryl compounds.
4. For direct sulfonation of aliphatics.
5. For sulfonations in the presence of a solvent, thus eliminating the removal of H_2SO_4 necessary when oleum is the agent.
6. For formation of addition compounds with amines, valuable in organic synthesis.

Sulfuric Anhydride exists in three chemically equivalent physical modifications as indicated by data below. General Chemical's stabilized product is almost entirely Gamma-Form and its partially stabilized product is largely Beta-Form.

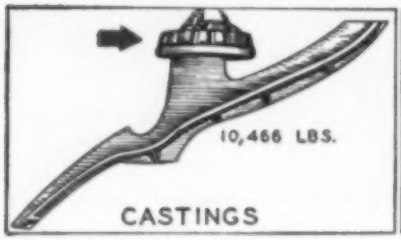
PROPERTY	GAMMA-FORM	BETA-FORM	ALPHA-FORM
Description	Ice-Like	Asbestos-Like	Asbestos-Like
Equilibrium			
Melting Point (°C):	16.8	32.5	62.3
Density (20°C)	1.9255	—	—
Sp. Ht. (cals/gm) (20°C)	0.77	—	—
Ht. of Fusion (cals/mol)	1,800	2,900	6,200
Ht. of Sublimation (cals/mol)	11,900	13,000	16,300
Ht. of Dilution (cals/mol)	40,340	—	—
Vapor Pressure (mm.)			
0°C	45	32	5.8
25	433	344	73
50	950	950	650
75	3,000	3,000	3,000

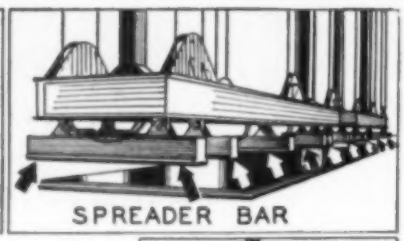
GENERAL CHEMICAL COMPANY

40 RECTOR STREET, NEW YORK 6, N. Y.

Sales and Technical Service Offices in principal cities from coast to coast

*Trade Mark, General Chemical Company





Lifting Magnets FOR ALL PURPOSES

You get definite saving of time and labor in moving material inside and outside of your plant with Stearns Lifting Magnets.

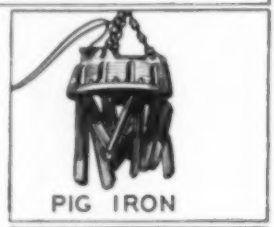
Will speed your loading and unloading operations—obviate hand labor on dangerous and difficult jobs—increase storage capacties—reduce your costs.

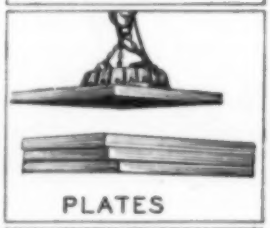
Let Stearns give you a lift with sturdy, dependable, low initial and operating cost magnets. Can be had in all practical sizes and shapes to suit your requirements.

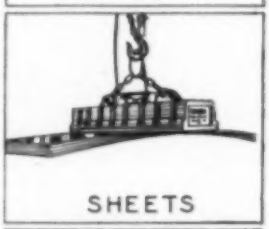
Stearns Magnets are being successfully and profitably used in handling scrap iron, loose or baled; steel plates, coils, bundles, strips; rails, slabs, billets, pig iron, castings, borings, turnings, finished products, etc., as well as for road and floor sweeping purposes. Can be installed on industrial crane trucks for out of the way spots not reached by overhead cranes.

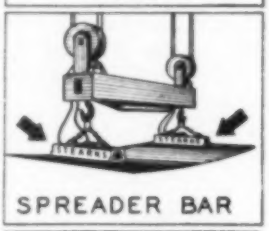
Stearns Magnets pay for themselves in a short time, require surprising little attention, are your best bet for economical, fast and safe moving of material.

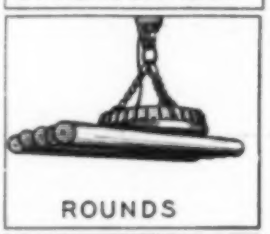
And—we can furnish Suspended Separation Magnets also in sizes and shapes to do your work.











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EQUIPMENT

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remove paint easily and quickly. It is effective in removing varnish, enamel and lacquers from wood without raising the grain. It contains no abrasives and gives off no dangerous fumes. It may be applied by swabbing with a brush, by use of a spray gun, or by immersion. Most paints or enamels are loosened in a period of five to fifteen minutes. The second of these new compounds was developed for the stripping of carbon, paint, varnish, adhesive detergents, oil and grease from automotive and aircraft engines and parts. It is a non-flammable cold tank cleaner known as Transpo. It is used at room temperature and is applied by dipping. It is non-corrosive to aluminum, magnesium, cadmium plates, steel, zinc, cast iron and tinplate.

57. Corrosion Preventives

PREVENTION of corrosion of oil and gas equipment can be accomplished by a new class of reagent, according to the Tretolite Co., St. Louis 19, Mo. Designated as Kontol corrosion preventives, these inhibitors have been shown in laboratory and field tests to be effective in reducing the corrosion in pumping and condensate wells. Kontol 115 is a non-toxic, oil soluble, nearly odorless liquid which lends itself to treatment of oil and gas wells. It does not react with salts carried by the brine, nor does it raise the pH of the brine. It is a surface active agent and builds up a thin film on the metal surface and protects the metal from corrosive elements in either brine or condensate.

58. Organic Intermediates

Two new organic chemical intermediates have recently been announced by the B. F. Goodrich Chemical Co., 324 Rose Bldg., Cleveland 15, Ohio. The first of these, 2-amino ethyl sulphuric acid, is a white crystalline material of high purity, readily soluble in water but insoluble in most organic solvents. It should find usage as an intermediate in the preparation of heterocyclic nitrogen compounds such as ethylene imine and other ring systems containing both sulphur and nitrogen. Since amino ethyl sulphuric acid will react with most compounds containing an active hydrogen atom, the material should be widely applicable as an amino-ethylating agent.

The second of these compounds has the trade name of Rhodanine and is known as 2-thio-4-keto-5 thiazolidine, an heterocyclic compound containing a reactive methylene group. Crystalline in nature, it is pale yellow in color and is soluble in alcohol, alkali, ether, and hot water. It reacts readily with

"IRCAMET"
A special corrosion-resistant alloy, containing high chromium and nickel with molybdenum and low carbon. (Other materials available for special services.)
"LEAKOLLECTOR"
The new I-R patented gland, collects all stuffing-box leakage so it may be led to a convenient point.
"CAMERON SHAFT-SEAL"
I-R pumps may be equipped with this modern solution to stuffing-box problems that is the talk of the pump world.
Removable Suction Nozzle gives access to impeller without disturbing the discharge piping.
Stainless-steel shaft is short, rigid, and runs in heavy bearings. This prevents impeller whip and eliminates many stuffing-box troubles.
Ingersoll-Rand

At HOME ON THE pH RANGE

The I-R brand on a chemical pump assures you of a unit especially built for chemical service. You have a pump that will stay on the job because it has built into it years of research and field testing.

Materials used will be right for your job—I-R chemical pumps have what it takes to run the whole pH scale, from hydrochloric acid to caustic soda.

Request complete information on these high-efficiency pumps built for long life on corrosive liquid service.

AIR TOOLS
COMPRESSORS
CONDENSERS
ROCK DRILLS
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OIL & GAS ENGINES

Ingersoll-Rand

10-972 11 BROADWAY, NEW YORK 4, N. Y.—CAMERON PUMP DIVISION

SAFETY is Basic in Schneible Dust and Fume Control!

Where collected dust and fumes embody a fire or explosion hazard, you will usually find Schneible wet method equipment. Approximately 500 Schneible Multi-Wash Collectors were installed in shell loading and manufacturing plants to handle TNT dust and vapor.

In Schneible collectors water (or other liquid) is used to remove all contamination from the collected air. The separated solids, as sludge, permit safe and easy disposal. There is no accumulation of dust to create a hazard and an added disposal problem.

All Schneible systems, including ductwork, are correctly engineered—with emphasis on safety. Numerous designs of hoods, nozzles and down draft benches are available. Submit your dust, fume and odor control problems.

SCHNEIBLE
DUST AND FUME CONTROL HEADQUARTERS FOR THE PROCESS INDUSTRIES

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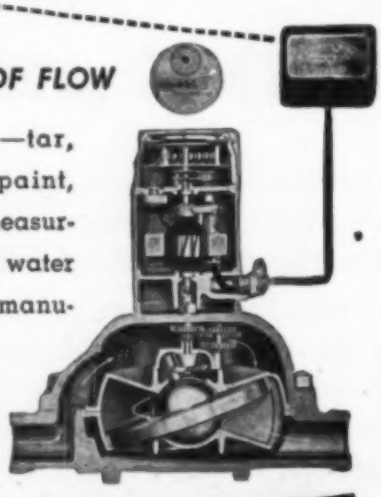
Engineering Representatives in Principal Cities

NEW
HAYS Veriflow
TOTALIZING-INDICATING
METER

Featuring
REMOTE INDICATION OF RATE OF FLOW



For practically all liquids—tar, molasses, crude oil, grease, paint, varnish, syrups, etc., etc.—for measuring, indicating, totalizing flow of water and chemicals in continuous manufacturing processes and numerous other uses. Its remote indicating feature is new—get the complete story.

SEND FOR BULLETIN 46-766

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

aromatic aldehydes and the resulting derivatives are useful as intermediates for the manufacture of arylamino acids, arylthiopyruvic acids, arylacetic acids, arylacetonitriles, and arylethyl amines with high yields. A number of other reactions can be developed readily. Neither of these two materials have been commercially available in the past so that their use heretofore has been considered only from an academic viewpoint.

59. Surface Active Agent

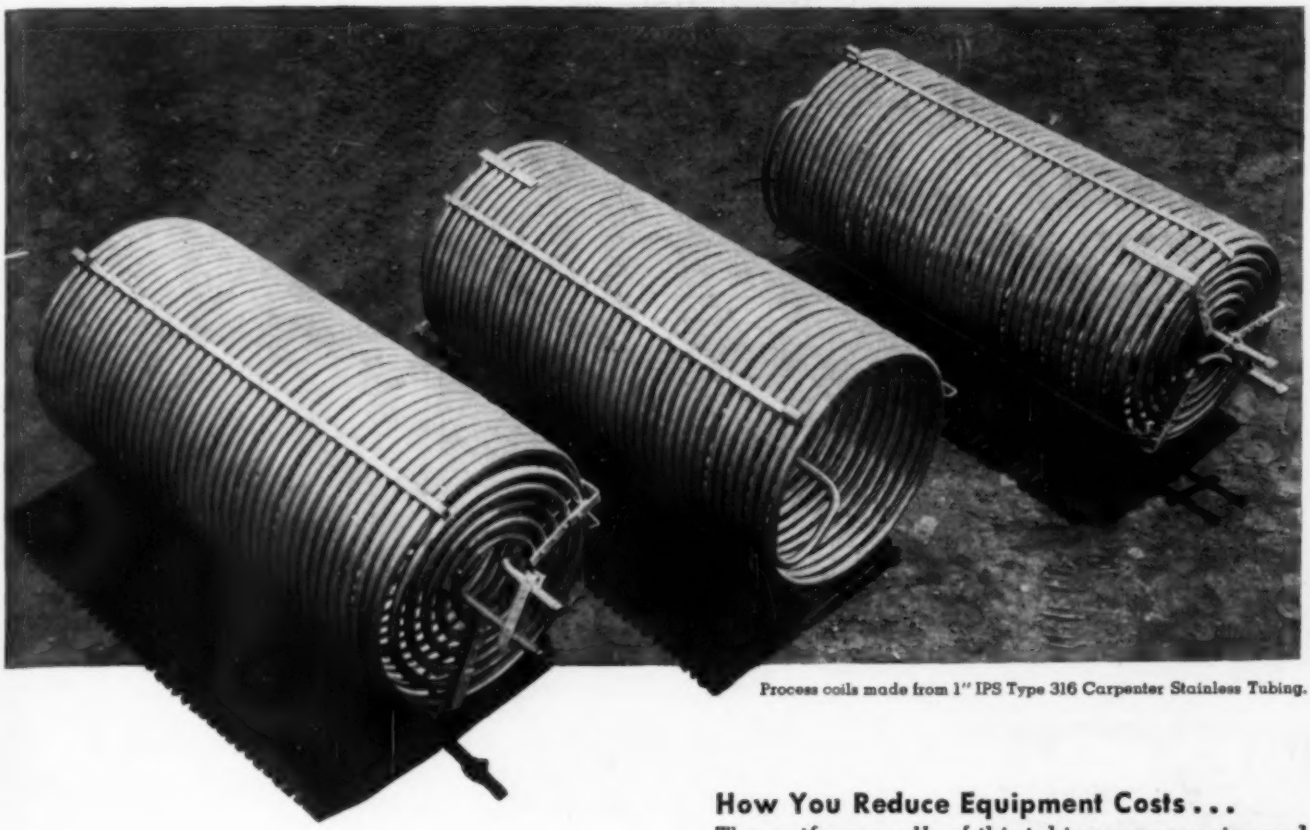
Now available from the Protean Chemical Corp., 150 Nassau St., New York 7, N. Y. is a surface active agent designated as Lamepon. Lamepon is the sodium salt of a fatty acid with a polypeptide where the fatty acid is substituted on the nitrogen atom. It is a viscous amber-colored liquid, approximately 42 percent solids and 58 percent water with a specific gravity of 1.14. The solids are approximately 37 percent active ingredients and 5 percent sodium chloride with traces of sulphate, sulphite and phosphate. Lamepon is miscable with water in all proportions, passing through a gel stage until the water content exceeds 50 percent. It can be made more soluble by adding 2 to 5 percent of denatured alcohol or other solvents. When undiluted this material is not subject to mold or bacterial decomposition. However, bacterial decomposition may occur in concentrations below 50 percent unless proper preservation materials such as formaldehyde are added. This material may be used in textile operations, for cosmetics, and in similar products. It is also suggested for use in the manufacture of soap, as a household and laundry detergent, for emulsions, cleaning compounds, and a variety of other products.

60. Cyclotron Oil

Developed by the Gulf Oil Corp., Pittsburgh, Pa., is a new type of oil designed to withstand the catalytic action of the large amounts of copper used in cyclotron production of radioactive elements. This oil is highly resistant to the deteriorating action of the copper. Transformer oils which have been chiefly employed in this type of application in the past have had to be frequently replaced or reconditioned because of the severe service.

61. Sealing Compositions

Used for sealing metal containers, a new sealing compound has been announced by the Thomas W. Dunn Co., Pearl & Dover Sts., New York, N. Y. Having the brand name of



Process coils made from 1" IPS Type 316 Carpenter Stainless Tubing.

You can reduce equipment costs and *improve* processing with *Carpenter* Stainless Tubing!

How You Reduce Equipment Costs . . .

The *uniform walls* of this tubing mean easier and faster bending, flanging or rolling into tube sheets. That saves time and reduces labor costs. It saves money for you. Carpenter Stainless Tubing can often be bent on a radius as short as 1½ times the diameter of the tube.

How You Improve Processing . . .

Full corrosion resistance and faster heat transfer are two advantages you get with Carpenter Stainless Tubing. Inside and outside tube surfaces are rigidly inspected, in addition to hydrostatic, tolerance and straightness tests. With this tubing on the job, you'll have less down time for replacement and repair work.

Detailed Engineering Data on Stainless Tubing . . .

Here is easy-to-use data on velocity constants, mass velocity constants, sq. ft. internal and external surface per lineal ft. tube, sizes and analyses available, etc. For your copy of the Carpenter Stainless Tubing Slide Chart, drop us a note on your company letterhead, indicating your title, please.

THE CARPENTER STEEL COMPANY

Welded Alloy Tube Division • Kenilworth, New Jersey

CARPENTER STAINLESS TUBING for

—Strength and Rigidity
—Weight Savings
—Corrosion Resistance
—Heat Resistance
—Accuracy
—Fabricating Savings
—Longer Service Life
—Sales Appeal

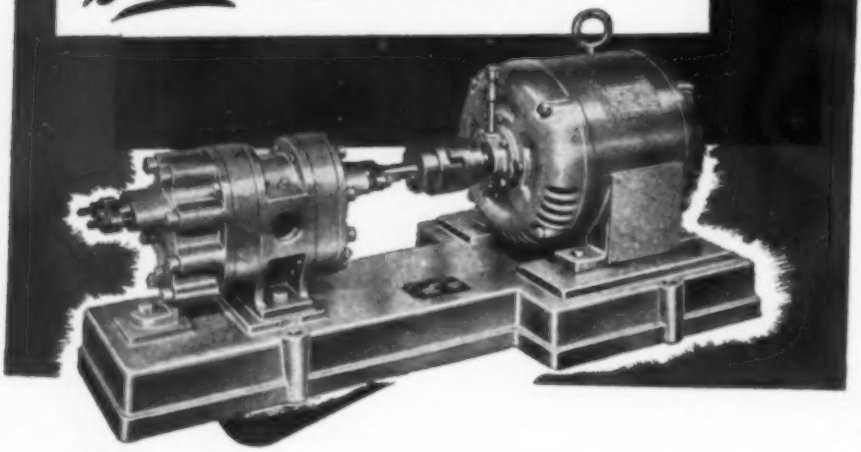
Carpenter

STAINLESS TUBING

Sier-Bath Precision Built

GEAREX ROTARY PUMPS

slash maintenance costs



The high cost of maintenance crews plus increased competition make mechanical breakdowns more costly than ever before.

Sier-Bath employs "tool room" manufacturing methods to give Gearex Pumps closer tolerances and better fitting parts . . . the answer to pump maintenance problems. Exact rotor clearance is achieved by accurate timing gears and roller bushings. The result: maximum operating efficiency at high speeds. Non-contacting rotors cut wear. Vibrationless operation does away with costly foundations. Pulseless flow eliminates wasteful wear on attachments . . . they last longer and need less attention.

Your choice of horizontal or vertical models . . . of steel or special alloys for specific applications. Jacketed bodies are available for high temperature jobs. Write for full details today.

• Balanced Axial Thrust • Pulseless Flow • Vibrationless Operation
• Roller Bushings for Precision Running under load

PUMPS: Oils, Varnishes, Solvents, Molasses, Chemical Solutions.
CAPACITIES: 1-550 g.p.m.
DISCHARGE: 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water.

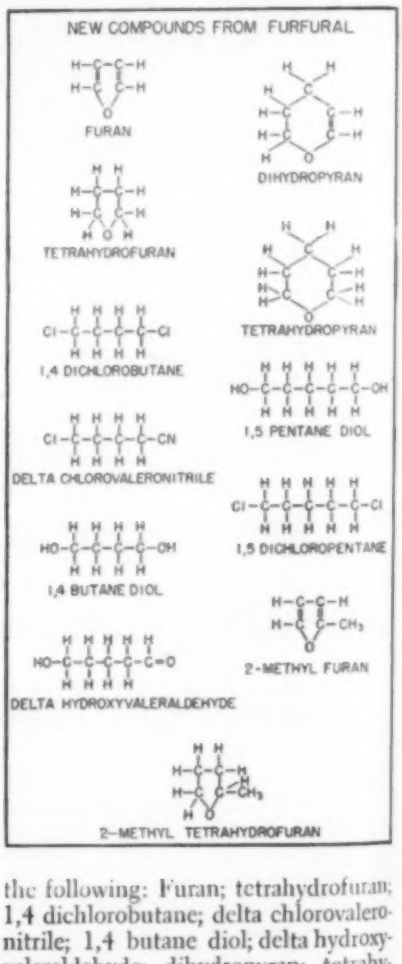
FOR HIGHER PRESSURES AND CAPACITIES USE SIER-BATH SCREW PUMPS

Sier-Bath GEAR and PUMP CO., Inc.

Dunnflex, this material is used between seams of metal containers. It is resistant to aromatic and aliphatic hydrocarbons, alcohols, vegetable, animal and mineral oils and greases. However, it may not be used for protection against leakage of aqueous materials since prolonged exposure to water causes Dunnflex to swell and soften. It is applied by spraying it in a water solution at 130 deg. F. onto flanges of the body or ends of the containers which are to be sealed.

62. Furfural Chemicals

A NUMBER of furfural compounds have been manufactured in pilot plant quantities by the E. I. du Pont de Nemours & Co., Niagara Falls, N. Y. These compounds are intermediates in the production of adiponitrile which is used in the manufacture of nylon. As shown in the chart they include

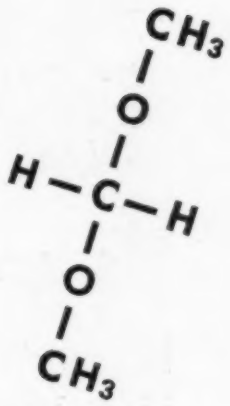


the following: Furan; tetrahydrofuran; 1,4 dichlorobutane; delta chlorovaleronitrile; 1,4 butane diol; delta hydroxyvaleraldehyde; dihydropyran; tetrahydropyran; 1,5 pentane diol; 1,5 dichloropentane; 2-methyl furan; 2-methyl tetrahydrofuran.

63. Aluminum Roof Paint

WEATHERPROOFING and summer cooling for homes, farm buildings and business structures is now possible by use of a new aluminum paint made by

METHYLAL
(dimethoxy-methane)
A CELANESE* CHEMICAL FIRST



Now, for the first time, methylal (dimethoxy-methane) is available in quantities which justify large scale experimentation and pilot plant development. Celanese' pure methylal holds promise of extensive application in processes that require a low boiling, extremely high power solvent.

As a solvent for plastics and other organic compounds, methylal is superior to ether and acetone in many respects—its relatively high water solubility and ability to be salted out of solution are characteristics of specific value. Its low boiling point (42°C) and stability toward alkalies points to its value as a vaporizing, extraction or reaction solvent.

	PHYSICAL PROPERTIES	TENTATIVE SPECIFICATIONS
METHYLAL CONTENT	100%	95% Min.
COLOR	Water White	Water White
SPECIFIC GRAVITY $\frac{20°C.}{4}$	0.8601	0.8600—0.8630
FLASH POINT, OPEN CUP, approx.	0° F.	0° F.
BOILING POINT,	42.3° C.	41.5°—43.5° C.
REFRACTIVE INDEX, n $\frac{20°C.}{D}$	1.3534	1.3530—1.3550

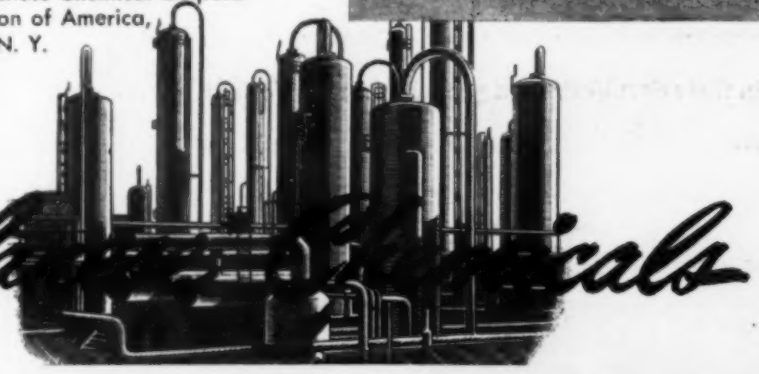
Celanese production of methylal will be expanded to meet volume requirements as they develop. Write for experimental sample and specification bulletin. Celanese Chemical Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

TETRAHYDROFURANE

Available now in pilot plant quantities, this solvent and intermediate is scheduled for quantity production in the near future.

	PHYSICAL PROPERTIES	TENTATIVE SPECIFICATIONS
COLOR	Water White	Water White
SPECIFIC GRAVITY, $\frac{20°C.}{4}$	0.8880	0.8840—0.8890
FLASH POINT, OPEN CUP,	approx. 70° F.	70° F.
BOILING POINT,	66° C.	63°—68° C.
REFRACTIVE INDEX, n $\frac{20°C.}{D}$	1.4070	1.4045—1.4075

Among its many uses, tetrahydrofurane is an exceptional solvent for vinyls and other plastics, and also is an unusual intermediate for the manufacture of adipic and succinic acids and many other compounds.



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FLOREX* and Florite*

are inexpensive natural catalysts which modern refiners use with the most satisfactory results in their desulfurization processes. Samples and technical data are available on request. Inquiries are welcomed.

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Department A, 220 Liberty Street Warren, Pa.

the United Gilsonite Laboratories, Scranton, Pa. Known as Gilsalume, this coating consists of a gilsonite asphalt and pure aluminum pigment. It is claimed to reduce interior temperatures by deflecting the heat rays from the sun. It is suitable for use on asphalt shingles, smooth or slate roll roofing, built-up slag or metal roofs, non-porous masonry and outside metal work including tanks, fences and flashing. It is applied with brush or spray gun. One gallon covers approximately 400 sq. ft. It is available in quart, gallon and 5-gal. containers ready mixed.

64. Methyl Grignard Reagent

COMMERCIAL production of methyl Grignard reagent has been announced by the Arapahoe Chemicals, Inc., Boulder, Colo. Heretofore this reagent has been made up by the user, but now that commercial production is taking place, this reagent will be commercially available for research and pilot plant work. Methyl Grignard reagent is available as a two molar solution of methyl magnesium bromide in ethyl ether, and will be supplied in quantities from 500 grams of solution to drum lots. It can be used in the synthesis of complex hydrocarbons, secondary and tertiary alcohols, methyl ketones and metal alkyls. It is also useful in the determination of active hydrogens by the Zerewitinoff method, and for the complete dehydration or removal of alcohol from organic solvents.

65. Liquid Rust Remover

A NON-EXPLOSIVE, non-flammable liquid rust remover that can be effectively used without injuring the metal is now available from the Allied Products Co., 1133 West Newport St., Chicago 13, Ill. Marketed under the brand name of Korodex, this new rust remover is said to be effective on any metal surface for removal of thick coats of rust. It is claimed to penetrate sufficiently to reach pinpoint spots, pits, crevices, cracks or corners and may be applied with a paint brush or swab but articles may also be treated by dipping them in the material. It is claimed to be non-toxic and non-injurious to personnel. Korodex is said to dissolve light rust in a few minutes while longer applications will remove coatings up to ¼ in. thick.

FOR MORE INFORMATION
See Reader Service Coupon on pages 183-184

CHEMICAL ENGINEERING NEWS

Richard F. Warren, ASSISTANT EDITOR

Atomic Energy Featured at Mid-America Exposition

BENEFITS to industry from peacetime research and development of atomic power will be the theme of the Mid-American Exposition to be held in Cleveland, May 22 to 31.

The exhibit, entitled "The Atom in Peacetime," is being planned with some cooperation of the Atomic Energy Commission, which, it is understood, may take over some of the displays to show in other cities later on. The display units will demonstrate various practical industrial developments of atomic energy as for example, the leak detector, high vacuum pumps, and radioactive tracers in industry. Feasibility of the use of atomic energy as a source of electrical power in industrial life, will be emphasized.

Exhibits are planned to show various medical aspects of atomic energy, also safety factors involved in its use, information and equipment to be obtained from Oak Ridge.

A model of the "Daniel Power Pilot Plant" now in the process of development at Oak Ridge, is being prepared under the technical guidance of the Monsanto Chemical Co., operators of the Clinton Laboratories at Oak Ridge. A replica of Dr. John R. Dunning's nuclear fission demonstrator under construction in California, will also be shown.

Both the Army and Navy will participate in the exposition. According to present plans, the Navy will indicate the future of atomic power plants in naval vessels and aircraft, and will have on hand some special electronics equipment and devices. There will be exhibits demonstrating some results of research on the use of radioactive tracers in the Navy's medical studies. Photographs, motion pictures, safety devices, and instruments from "Operations Crossroads" will be displayed.

Participating organizations and companies to date include: Atomic Energy Commission, Monsanto Chemical Co., Union Carbide and Carbon Corp., Westinghouse Electric Co., Kellex Corp., Victoreen Instrument Co., Clinton Laboratories, American Chemical Society, American Medical Association, Brookhaven National Laboratories, Case School of Applied Science, Western Reserve University, University of Illinois, Carnegie Tech, and University of Pittsburgh.

Frye is Made Chairman Of General Aniline

ATTORNEY GENERAL Tom C. Clark has announced the election of Jack Frye as chairman of the board of General Aniline & Film Corp. and of General Dyestuff Corp., sales agent for General Aniline & Film Corp., by the directors of the respective companies at separate meetings held in New York. General Aniline & Film is 97 percent owned and General Dyestuff is wholly owned by the United States Government through the office of Alien Property of the Department of Justice. George Burpee was reelected president.

Consultants Hear Talk On Market Research

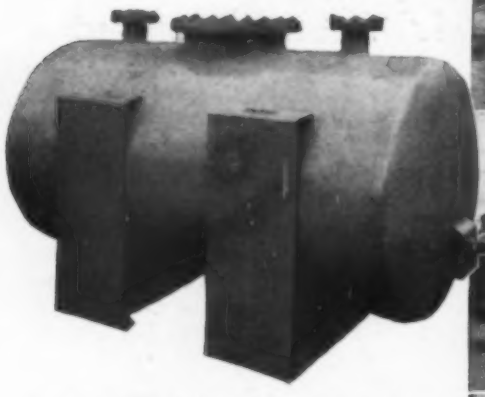
FOLLOWING the presentation of the first honorary membership in the society to Col. Marston T. Bogert, at the Hotel Shearton, New York, April 21, members of the Association of Consulting Chemists and Chemical Engineers heard C. C. Concannon speak on Market Research. Mr. Concannon, chief, Chemical and Drug Division, Department of Commerce, revealed that the government is now printing a Chemical Statistics Directory which is designed to give a list of references available on a particular chemical. The directory is intended to cover government releases issued in 1945 but it has been expanded to include other basic reference material, including the latest Census of Manufactures. It will be issued annually.

Raw Materials Survey Service Set Up in Northwest

A NEW service is now available to the chemical and other industries of the country through the formation in Portland, Ore., of the Raw Materials Survey, a non-profit organization supported by banks, public utilities, and other organizations in Oregon and southern Washington. Believed to be the first comprehensive set-up of its kind not limited by type of commodity or geographical boundaries, the purpose of the Survey is to collect basic factual engineering and economic data on sources of raw materials needed by present and potential industries of the area. It is not primarily concerned

In ceremonies held April 14, 1947, at Governors Island, General Courtney H. Hodges, First Army Commander, presented the President's Certificate of Merit to six prominent engineers, in recognition of "outstanding fidelity and meritorious conduct in aid of the war effort, by formulating proposals on postwar industrial control measures in Germany and Japan." From left to right are: Malcolm Pirnie, Carlton S. Proctor, Robert E. McConnell, Medley G. B. Whelpley, Harry Stanley Rogers, and Sidney D. Kirkpatrick

ONE MAN — ONE TRUCK —ANY NUMBER OF BODIES



In this installation, bodies happen to be rubber lined acid tanks. Built for any liquid or gas, in 500, 750, 1000 gal. capacities. It's the Dempster-Dumpster system of low cost materials handling - one truck hoisting unit handles any number of a dozen different types of regular or special types of bodies to suit your requirements, up to 10 cubic yards capacity. Write for catalog now.

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with local raw materials, but is intended to show where adequate supplies of any proper raw material, mineral or chemical, may be obtained most economically.

Permanent chairman of the operating committee is Brig. Gen. T. M. Robins, formerly deputy chief of the U. S. Engineers in Washington, D. C., now a private consultant in Portland. Managing engineer is Richard J. Anderson, formerly resident geologist of Alcoa Mining Co. at Portland. Chester K. Sterrett, manager of the Industries Dept. of the Portland Chamber of Commerce, is secretary of the Survey.

Celanese Erects Pulp Plant in Canada

ERECTION of a $10 million cellulose pulp plant will be undertaken at Prince Rupert, B. C. The mill will be constructed and operated by the Celanese Corp. of America at Port Edward, site of the wartime base of the United

CONVENTION CALENDAR

American Oil Chemists Society, 38th annual meeting, New Orleans, La., May 20-22.

American Society of Mechanical Engineers, oil and gas power 19th national conference, Cleveland, Ohio, May 21-24.

American Society for Quality Control, first annual convention and exhibit, Hotel Sherman, Chicago, Ill., June 5-6.

Chemical Market Research Association, annual business meeting, Hotel Biltmore, New York, N. Y., June 5.

University Conference on Corrosion and Metal Protection, Museum of Science and Industry, Chicago, Ill., June 11-13.

American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 16-20.

Instrument Society of America, second annual instrument conference and exhibit, Stevens Hotel, Chicago, Ill., September 8-12.

American Chemical Society, 112th national meeting, New York, September 15-19.

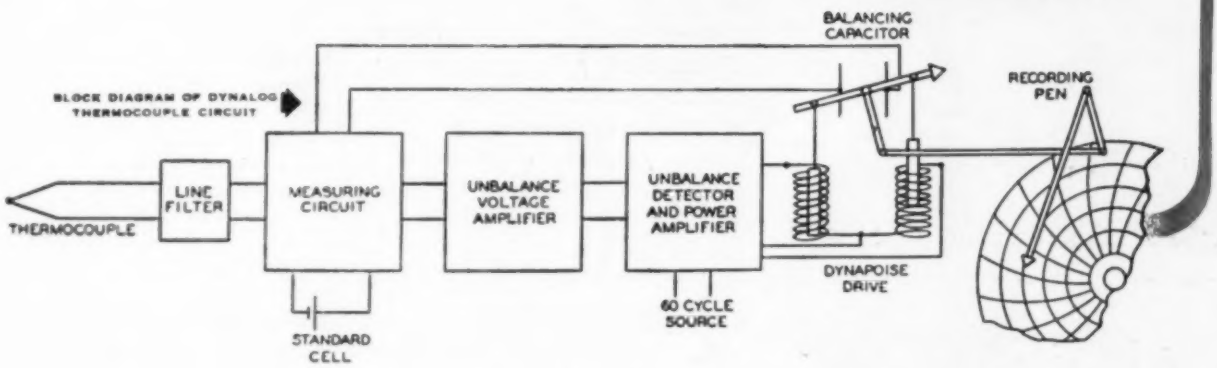
American Institute of Chemical Engineers, regional meeting, Hotel Statler, Buffalo, N. Y., September 29-October 1.

Electrochemical Society, fall congress, Copley-Plaza Hotel, Boston, Mass., October 15-18.

Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif., October 21-25.

Exposition of Chemical Industries, 21st exposition, Grand Central Palace, New York, N. Y., December 1-6.

NEW DYNALOG CONTROLLER for THERMOCOUPLES



Practically Eliminates Maintenance!

EMPLOYING THE FIRST wholly-electronic design ever developed for industrial thermocouple instruments, Foxboro's DYNALOG Controller offers a combination of speed, accuracy and sensitivity never before available in controllers.

What's more, the simplicity of DYNALOG design practically eliminates maintenance. Here's why:

NO SLIDEWIRE—Complete slidewire mechanism is replaced by simple balancing capacitor.

NO MOVING CONTACTS—Slidewire contact is eliminated by positive-connected capacitor.

NO GEARS—Only simple direct linkage.

NO ROTARY MOTORS—Balancing drive motor is simple push-pull magnetic type. No brushes, commutator or bearings.

NO GALVANOMETER—Not affected by vibration.

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Write for Bulletin 397 containing full details of DYNALOG Controllers in air-operated (Model 40) and electric (Rotax) types. **The Foxboro Co., 16 Neponset Avenue, Foxboro, Mass., U. S. A.**

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ELECTRIC *Crescent* PALLETIER

States Army. Announcement of the plan of final arrangements and the start of construction of the plant has been made by Hon. E. T. Kenney, Minister of Lands for British Columbia. Mr. Kenney said the deal provided that the plant will produce from 200 to 400 tons of highly purified cellulose per day for chemical purposes. Construction of the plant will take two years.

The site on Watson Island at Port Edward is eight miles southeast of Prince Rupert. Docking facilities for ocean-going vessels were erected at Port Edward during the war by the U. S. Army and communications made to the island by the Canadian National Railways and by the provincial highway system. D. G. Stenstrom, special adviser to the new company, states that Prince Rupert will actually be the headquarters for the industry. He states workmen will live in Prince Rupert and commute to their job and that about 400 men will be employed on construction work. A British Columbia company, known as the Port Edward Cellulose Co., Ltd., has been formed as a subsidiary of the Cellulose Corp. of America.

To assist the new project Mr. Kenney states that the B. C. government has arranged to set aside a large tract of forest land north of Prince Rupert, including sections of the Nass and Skoena Rivers watershed and Portland Canal area.

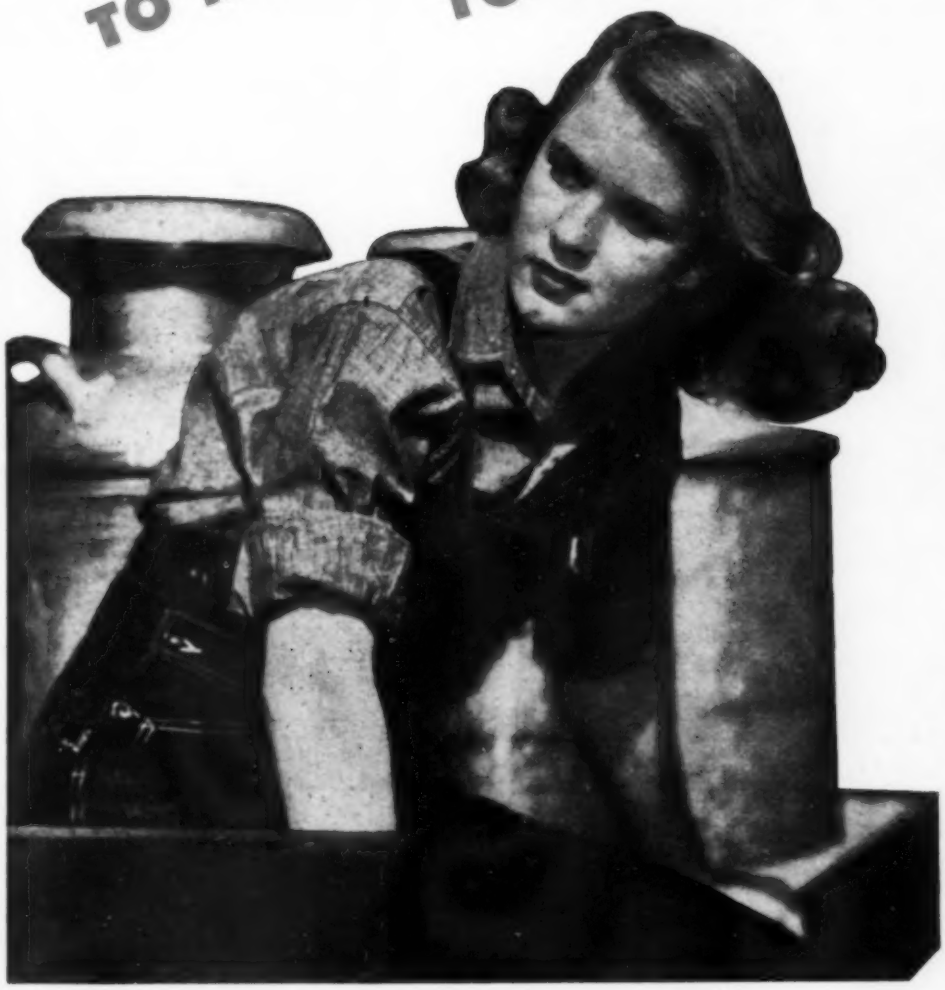
New Cement Plant Has Doubled Capacity

NEW facilities for the manufacture of corrosion proof cements and paints, doubling former capacity, have been completed in the Natrona plant of the Pennsylvania Salt Mfg. Co. The unit went into production last month. Formerly these products of Pennsalt's special chemicals division were manufactured at the Philadelphia plant. In addition to increasing capacity, newly developed processes were installed to improve production methods and also to permit manufacture of a wide range of new products now in the development stage.

Johns-Manville Purchases Goetze Gasket

COMPLETION of the purchase on March 30 of the factories and other properties of the Goetze Gasket & Packing Co., Inc., of New Brunswick, N. J., manufacturers of metallic gaskets by Johns-Manville was announced by Lewis H. Brown, chairman of the board of Johns-Manville Corp. By the terms of the purchase, under an agreement signed in February, Johns-Manville acquires the factories and other

TO MARKET, TO MARKET



and what happens THEN

EVERY day in the year, on its way to America's tables, a flood of milk moves into the shining plants of the great Dairy Industry—there to be pasteurized and processed, predominantly in equipment made of stainless steel.

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W&D 213-B

We produce stainless steel in all of its forms, and for all of the industries where—as in dairy practice—it has set new standards of performance. When you think of stainless steel, think first of Allegheny Stainless.

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Stop SLUDGE!

Nothing can damage expensive pressure control equipment quicker than a bit of dirt, pipe scale, or foreign material in the working parts. Protect this expensive equipment by the proper installation of a good sturdy strainer in the line just ahead.

The new CASH-ACME "Y" Type Strainer is ruggedly built around two hundred and fifty pound cast iron standard. Brass and cast iron available. ⅛" to 2" pipe sizes. Standard or special screen.

See your Mill Supply dealer ask for CASH-ACME Automatic Valves.

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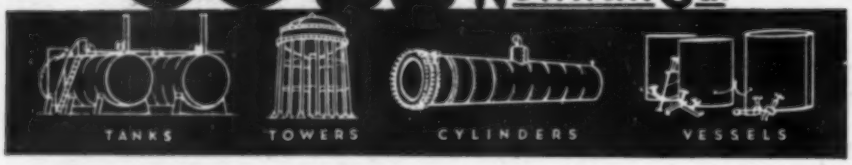

physical properties and the going business of the Goetze Gasket & Packing Co., Goetze gaskets will be produced as formerly, at the Goetze plant in New Brunswick and sold by Johns Manville under the Goetze name.

Case Becomes Institute of Technology in June

CLEVELAND'S Case School of Applied Science will, after June 1947, be known as Case Institute of Technology. Changing the name of the technical school, which came into being in 1880, incorporated a year later when actual instruction started, was brought about by President William E. Wickenden and confirmed April 1 by an order from the Court of Common Pleas of Cuyahoga County. Reason given by Dr. Wickenden for changing the name was the old name was out of line with the character of the present day institution.

Carbide to Double Its Polyethylene Output

POLYETHYLENE, although one of the newest members of the thermoplastic materials, has become so important commercially that Carbide and Carbon Chemicals Corp., is planning to double its wartime production of polyethylene resins at the South Charleston, W. Va., plant. Present production is already more than six times the original rated capacity and is far from sufficient to meet the demands of industry upon Bakelite Corp., which markets this

Architect's drawing of the new building under construction for Carbide and Carbon Chemicals Corp. at South Charleston, W. Va. This new 10-story building will serve as administrative, engineering, and operating headquarters and will occupy a frontage of 162 feet opposite the present plant administration facilities. It will accommodate some 900 employees of the corporation's administrative, engineering, and operating groups

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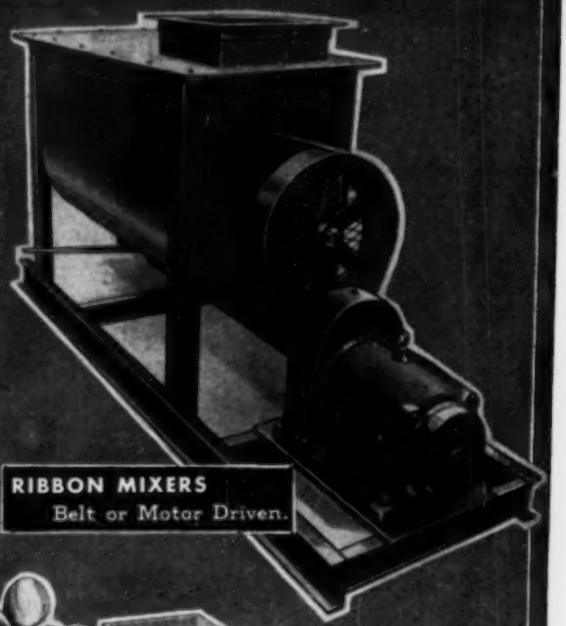

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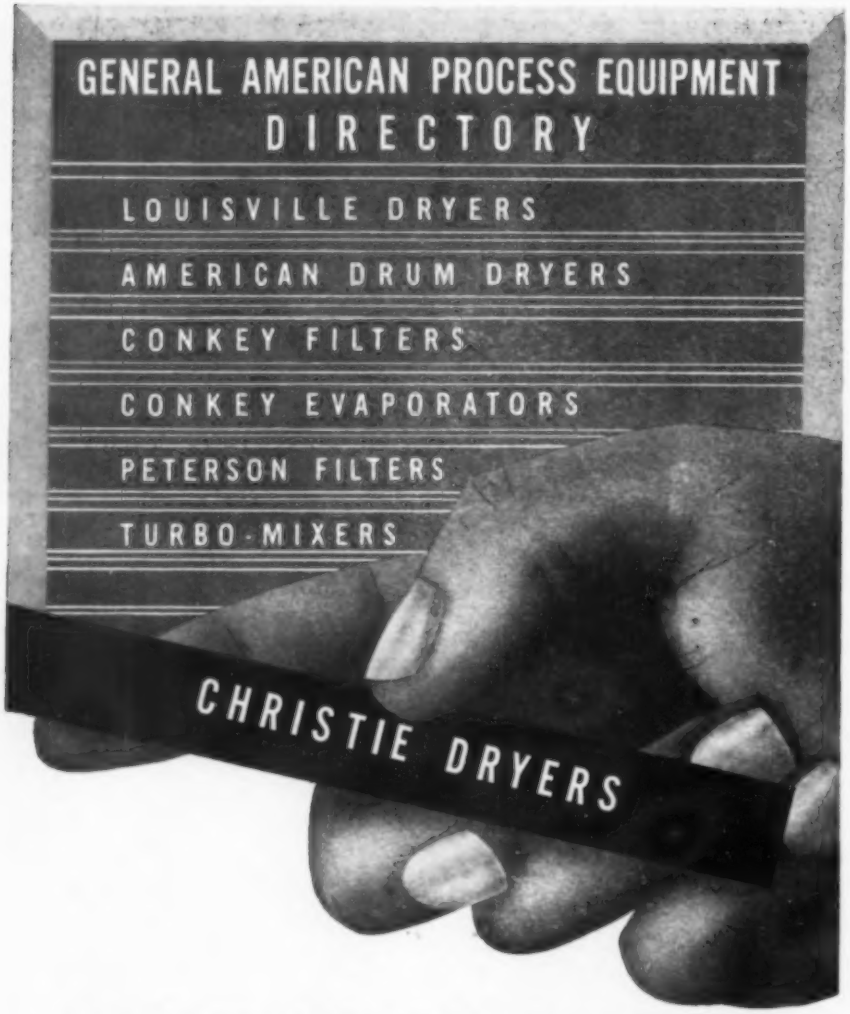

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In acquiring the L. R. Christie Company, General American Transportation Corporation has added a distinguished name to the roster of its Process Equipment, designed and fabricated for use in industry.

Users of Christie Dryers, Calciners, and Coolers can now draw upon the varied and accumulated experience of General American engineers when plant expansion requires additional process equipment.

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GATX GENERAL AMERICAN

plastic produced by units of Union Carbide and Carbon Corp. New plant construction, which will be completed early next year, will double the present large output.

AIC Medal Awarded at Annual Meeting

THE American Institute of Chemists held its twenty-fourth annual meeting, May 2 at the Hotel Commodore, New York, at which the gold medal of the Institute was presented to Dr. M. L. Crossley, director of research, American Cyanamid Co., in recognition of his scientific work, leadership in research and activities in behalf of the profession.

Speakers at the medal dinner were: Dr. Henry M. Wriston, president, Brown University, "Crossley as I Know Him"; Dr. Arthur J. Hill, director, Sterling Chemistry Laboratory, Yale University, "The Scientific Achievements of Dr. Crossley"; S. C. Moody, vice president, American Cyanamid Co. and general manager, Calco Chemical Division, "Crossley in Industry." Dr. Foster D. Snell, president, the American Institute of Chemists, made the medal presentation. Dr. Crossley's acceptance address was on the subject of "Research and Human Welfare."

New Detergent Plant Now Operating in California

AFTER a delay of several months caused by materials and equipment shortages, the first section of the drying operation in the new synthetic detergent plant at the Richmond, Calif., refinery of Standard Oil of California is ready to produce flake material in large quantities. Production of dry product will exceed 3 million lb. monthly, states G. L. Parkhurst, president of Oronite Chemical Co.

Although production of slurry began last autumn, the difficulty of obtaining the necessary dryers has delayed production of dry material. However, the new detergent is now readily available in slurry form to soapers and the general industrial trade; the final product will not be distributed by Oronite to the household market. The San Francisco firm is the only major commercial producer of synthetic detergent west of the immediate Mississippi Valley.

That Oronite intends to increase output of the synthetic detergent still further is indicated in a recent statement by Parkhurst, who pointed out that the firm is definitely looking ahead toward a manufacturing potential of 300-500 million pounds of product annually. This would represent

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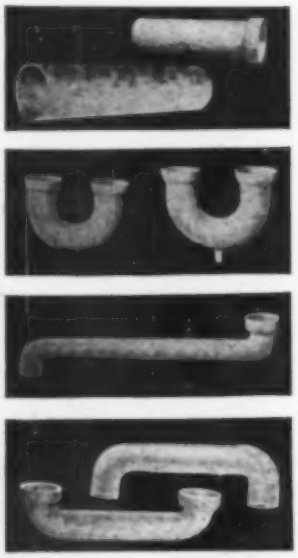

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PROVIDES on and off control of liquid or suction lines. Used with standard thermostats for positive control of refrigerants in either defrosting or reverse cycle systems, multiple temperature processes or with by-pass or unloading valves. Bodies are die forged and all internal parts are bronze or stainless steel.

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25-1

30-50 percent of the estimated market of 1 billion lb. expected to be reached by synthetic detergents, as a class, within the next few years. Already, Oronite is reported to be the largest single producer of synthetic detergent basic materials in the country.

The product, a surface-active agent of the alkyl aryl sulphonate type, is made from petroleum raw materials without the use of any vegetable fats or oils. Reported to be outstanding for its high foam-producing ability and lack of odor, Oronite synthetic detergent is said to be equal to or better than any similar product now on the domestic market. The new-type product was developed by an investigation initiated some years ago by the research subsidiary of Standard Oil Co. of California now known as California Research Corp. It is manufactured by Standard of California at its Richmond refinery for the firm's chemical subsidiary, Oronite Chemical Co.

Atomic Energy Commission Offers Heavy Water

THE Atomic Energy Commission has announced plans for the distribution of heavy water and deuterium gas to qualified research institutions in the United States. Distribution will be by the Stuart Oxygen Co. of San Francisco under contract with the Commission.

Carroll L. Wilson, general manager of the Atomic Energy Commission, said handling and distribution costs only were covered in the charges for the heavy water and deuterium gas. Heavy water was produced in connection with the atomic energy operations and now is available in sufficient quantities for domestic research purposes outside of the government's atomic energy program. The Stuart Oxygen Co. will convert heavy water to deuterium gas for applicants who need deuterium in the latter form, although Stuart is not the manufacturer. Because of the value of deuterium as a research tool and the importance of the experimentation to the atomic energy program, the Commission decided to make the material available free except for handling and distribution costs.

Applicants for deuterium oxide (heavy water) and deuterium gas will be charged an amount sufficient to cover handling and distribution charges of the contract distributor. The price schedule follows: Heavy water—50 c. per g. for the first 100 grams and 30c. per g. thereafter; Deuterium gas—$1 per liter (at normal temperature and pressure) for the first 100 liters and 80 c. per liter thereafter.

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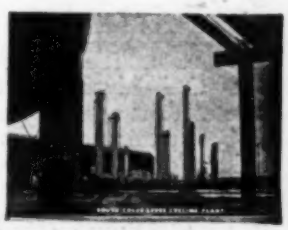
Thus, when you assign a construction contract to the FLUOR organization . . . whether it be of your own or of FLUOR design . . . you get the "know-why" which makes the "know-how" that counts. And that means a better job all the way . . . from plan to plant!

The South Coles Levee Cycling Plant, a recent example of FLUOR Engineering and Construction Services, is fully illustrated and described in this colorful brochure. Write for your copy today.



FLUOR PRODUCTS— Cooling Equipment, Mufflers, Gas Cleaners, Pulsation Dampeners
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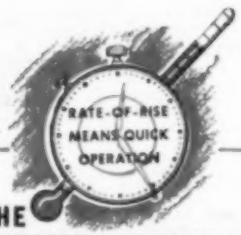
One of the most important fire protection developments introduced in recent years is the use of water in fine spray form for the control and extinguishment of fire. "Automatic" FIRE-FOG is an outgrowth of this development and is, by virtue of its performance, a leader in the field.

Among the many exacting installations of "Automatic" FIRE-FOG is one standing guard over butadiene unloading operations at the Goodyear operated Rubber Reserve Plant at Akron, Ohio. Naturally, the complexity of operational facilities at this plant demand carefully studied fire hazard safeguards for every process . . . safeguards that will withstand rigorous test under the most difficult conditions 24 hours every day in the year.

The significant thing about an "Automatic" FIRE-FOG installation is its readiness for instant — automatic action now next week — next year — in fact, whenever the danger of fire threatens.

You owe it to yourself, your personnel and your business to become fully informed on the merits of "Automatic" FIRE-FOG. Investigate today at no obligation. Write or call "Automatic" Sprinkler Corporation of America, Youngstown 1, Ohio.



THE SUPROTEX* SPRINKLER SYSTEM

—a famous member of the "Automatic Sprinkler Family. Designed particularly for use in manufacturing, mercantiles, warehouses, schools, churches, offices, hospitals, piers and other establishments where positive fire protection is essential.

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"Automatic" Sprinkler devices and systems are listed by Underwriters' Laboratories, Inc., and approved by Factory Mutual Laboratories.

FIRE PROTECTION

DEVELOPMENT ENGINEERING

"Automatic" Sprinkler

MANUFACTURE INSTALLATION

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA
YOUNGSTOWN 1, OHIO
OFFICES IN PRINCIPAL CITIES OF NORTH and SOUTH AMERICA

same manner as requests for radioactive isotopes produced in the pile at Oak Ridge and distributed by the Monsanto Chemical Co. Application forms may be obtained from the Atomic Energy Commission, Research Division, Isotopes Branch, Oak Ridge, Tenn. Applications will be screened by subcommittees of the Advisory Committee on Isotope Distribution in order to insure the most efficient use of the materials.

New Film Shows Results of Materials Handling Study

AMERICAN industry should scrutinize its methods of handling raw materials and finished products as a probable "Antarctica" of unrealized profits, lower prices and better employee relations. This was the gist of a two year study of materials handling reported in the form of a three-reel sound motion picture, "Pay Loads Pay Off," to representatives of the business press and industry at the Hotel Commodore, New York, March 12. The film shows a wide variety of materials handling problems and procedures concerning factories and warehouses. Using non-technical language, "Pay Loads Pay Off" forcefully, and often with humor, presents scenes which dramatize time and motion studies that contrast manual and mechanized handling methods.

Chemical Industry Mobilizing For December Exposition

ANNOUNCEMENT of the 21st Exposition of Chemical Industries to former exhibitors brought good response, and a large proportion of them have reengaged spaces previously occupied. Interest in the exposition gives assurance that four floors of Grand Central Palace will be fully occupied. The exposition will be held during the first week in December. The display again will combine chemicals and chemical products with all manner of equipment employed in chemical manufacture and by the processing industries.

Chemical products that are used as manufacturing ingredients present a never failing source of refinement and change. Processing apparatus, included in a major group of exhibits at the exposition, is passing through a period of change affecting the structure of equipment and machines of many kinds, and though this cycle of change will continue for several years to come, there is some reason to believe it may be approaching its postwar climax this year.

The exposition, as heretofore, will be under the management of the International Exposition Co. Charles F.

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Increase Production
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with this
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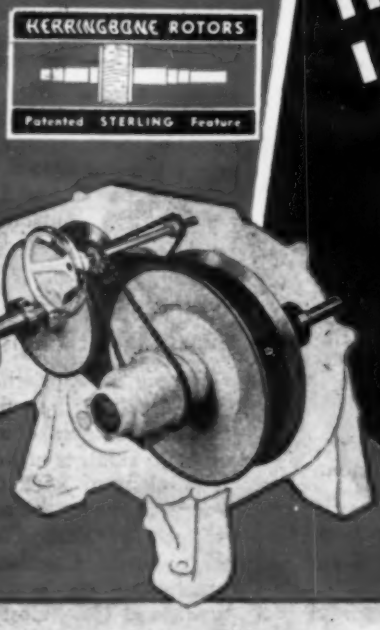
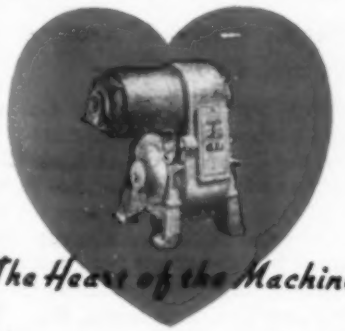
VARIABLE
SPEED POWER



STERLING SPEED-TROL MOTORS



The Heart of the Machine

A revolutionary design of infinite variable speed, varying from 2:1 to 6:1. ¼ to 15 H.P.

Sterling System Speed-Trol Units are compact, enclosed, self-contained, infinitely variable speed power units of lasting efficiency, incorporating thoroughly tried and proven principles.

Sterling Speed-Trol Motors make available a greatly improved and inexpensive system of machine drive for all industries—will increase production — improve products — decrease production costs — are revolutionary in their simplicity, and possess features long needed but heretofore never obtainable.

Write for complete information.

STERLING ELECTRIC MOTORS, INC.
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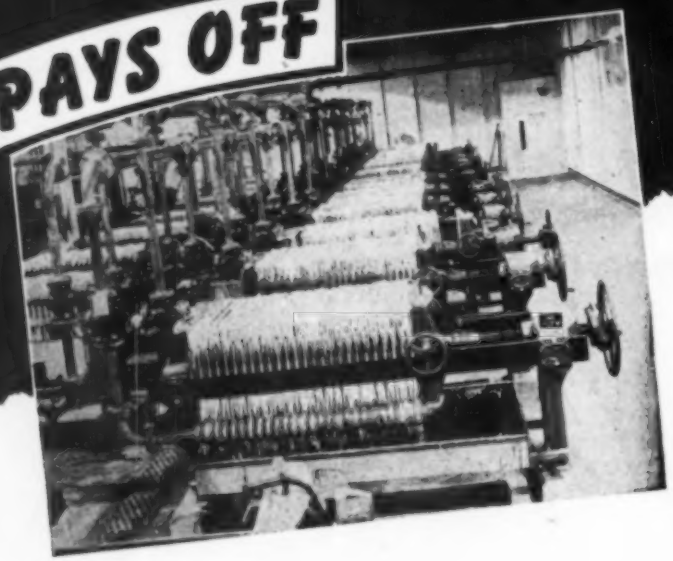
for Greater Perform-ability (Sm)

WHY OPERATING SHRIVER FILTER PRESSES PAYS OFF



LOW OPERATING COSTS

Shriver Filter Presses are easy to assemble, operate and clean with a minimum of unskilled labor. Since there are no moving parts, the only power required is for operating the feed pump. On the basis of actual filtering area, they require the least productive space at lowest production cost.

PERMANENT INVESTMENT

Shriver Filter Presses have permanent value because they can be used on any filterable material anywhere. They can be taken apart, moved and easily reassembled.

VERSATILE PERFORMANCE

Shriver Filter Presses more than just separate solids from liquids. They can wash and extract filter cake and even partially dry it. They clarify and bleach; redissolve and melt filter cake, or thicken the slurry.

FOR ANY CONDITIONS

Shriver Filter Presses are built of any metal, rubber, wood, rubber covered, plated or synthetic-coated metal to meet any conditions of corrosion. They are designed for operating at any pressure or temperature; for use of any filter media and filter aids; as portable or stationary units.

Write for Catalog • **T. SHRIVER & COMPANY, Inc.**
802 HAMILTON ST. HARRISON, N. J.

Shriver Filter Presses

Save TIME • SPACE • LABOR • INVESTMENT

Roth is manager and E. K. Stevens associate manager.

Chicago Chemical Library Seeks New Funds

A DRIVE for $100,000 to provide complete files of the world's technical literature for the use of research workers in the chemical industry of the Chicago area has been launched by the Chicago Chemical Library Foundation, sponsored by the Chicago Section of the American Chemical Society and the Chicago Chemists' Club, it is announced by the Foundation's board of trustees. The undertaking includes the establishment of an efficient microfilm service to increase the availability of technical data in Chicago to industries elsewhere.

Publications acquired with the $100,000 fund, which is to be spent over a ten-year period, will be placed in the John Crerar Library, one of the nation's outstanding scientific libraries.

Synthetic Solvents Output Expanded at Houston

PRODUCTION of the synthetic industrial solvents, methyl isobutyl ketone and methyl isobutyl carbinol will start this summer at the new Houston, Tex., plant of Shell Chemical Corp. The two solvents are now being manufactured by Shell Chemical on the West Coast. Contractor for the construction of the new plant is C. F. Braun and Co. Cost is estimated at $2,200,000, including general plant facilities.

Spencer Chemical Acquires Natural Gas Reserve

THE Sunflower Natural Gas Co., Inc., a wholly-owned subsidiary of the Spencer Chemical Co. of Kansas City, Mo., and Pittsburg, Kan., has recently purchased some 28,000 acres of mineral rights in Seward County, Kan., and Texas County, Okla., from Fred C. Koch and the Wood River Oil and Refining Co. of Wichita, Kan. The transaction was completed on March 7, 1947 but announced by the purchasers April 17.

The Spencer Chemical Co. reports that the purchase was made to assure the chemical and fertilizer company operating the Jayhawk Works near Pittsburg, an adequate supply of natural gas, which is used as a raw material, for many years to come. The purchase of these acres located in the Hugoton gas field represent approximately a 30 year supply of natural gas for the processing requirements of the Spencer Chemical Co. Substantial

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THE BABCOCK & WILCOX TUBE COMPANY
Beaver Falls, Pennsylvania

Please send me _____ copies of TECHNICAL BULLETIN 9-A . . . "Methods of Working Seamless Tubes and Pipe of the Intermediate B&W Croloys."

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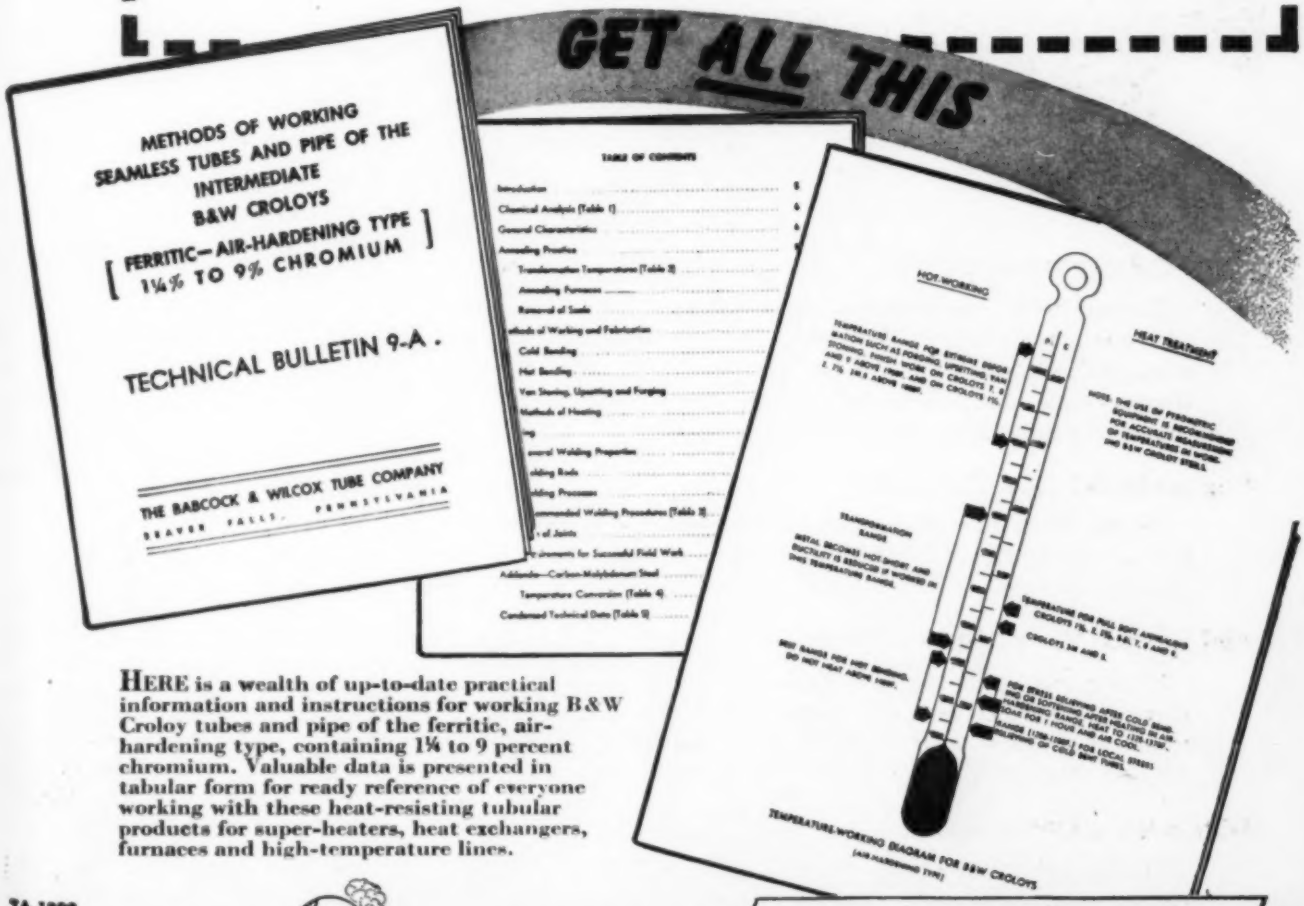

HERE is a wealth of up-to-date practical information and instructions for working B&W Croloy tubes and pipe of the ferritic, air-hardening type, containing 1¼ to 9 percent chromium. Valuable data is presented in tabular form for ready reference of everyone working with these heat-resisting tubular products for super-heaters, heat exchangers, furnaces and high-temperature lines.

TA-1392

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Water-Tube Boilers, for Stationary Power Plants, for Marine Service • Water-Cooled Furnaces • Superheaters • Economizers • Air Heaters • Pulverized-Coal Equipment • Chain-Grate Stokers • Oil, Gas and Multi-fuel Burners • Refractories • Process Equipment.

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SEAMLESS & WELDED TUBES
THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA.
PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.

BAKER TRUCK *multiplies manpower by* 10!

A Philadelphia coffee roasting company uses a Baker Fork Truck for handling bagged coffee in five separate operations—reducing tasks formerly requiring hours of hard, physical effort, to minutes of safe, light work. Besides achieving substantial man-hour savings, the truck more than doubles warehouse capacity by tiering palletized loads two and three high.

● Coffee is received in highway trucks, in bags (not palletized) weighing 150 to 200 pounds. Three men, working a full day formerly unloaded approximately 750 bags and piled them in the warehouse. Today, one operator with the Baker Truck, could easily unload 2500 bags. The truck first lifts the empty pallets onto highway truck from floor level. After bags are placed on pallets, the fork truck unloads and tiers the palletized units in the nearby warehouse area.

Since only a fraction of the truck's time is required for unloading and tiering, it is free to transport pallet loads of green coffee, in correct proportions for the desired blend, and spot them alongside the roasting station. This operation formerly took the *full time* of one man. Roasting completed, coffee is weighed off in 80 lb. bags and again palletized, so that the truck can move them either to temporary storage or load them directly into vehicles for shipment.

Whether your problem is handling bags, cartons, drums, bulky parts or practically any other material, the fork truck—pallet combination can save you money. Let the Baker Material Handling Engineer show you how.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Company
2145 WEST 25TH STREET • CLEVELAND, OHIO
In Canada: Railway and Power Engineering Corporation, Ltd.

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Member: Electric Industrial Truck Association

Baker INDUSTRIAL TRUCKS

quantities of coal will be used annually to generate power, thereby extending the life of gas, which is used for its chemical content and as a raw material to the manufacturing process, and not as a source of heat and power. The company announced that the service from the present supplier of natural gas at the huge works was satisfactory, and this purchase was made simply to supplement the present supply of the pipeline company now furnishing natural gas for the plant.

Spencer Chemical Co. reconverted the Jayhawk Ordnance Works into private commercial production in June 1946. The company's production during its first ten months has been restricted to anhydrous ammonia, ammonia nitrate fertilizer, and ammoniating solutions used in agriculture. A substantial construction program is now under way and, when completed, plans will be diversified to include, in addition to the present products, methanol, dry ice, liquid carbon dioxide, refrigeration grade ammonia, technical grade ammonium nitrate, industrial nitric acid and allied products.

Fused Phosphate Fertilizer Output Increased

IN RESPONSE to the greatest demand ever experienced in California for fertilizer materials, Permanente Metals Corp. has stepped up output of its Permanente, Calif., plant to some 6,000 tons monthly of Thermo-Phos, a fused calcium magnesium phosphate made by electric-furnace reaction of serpentine and phosphate rock. A new packer has been installed to turn out 10 bags per min., more than tripling the previous rate. The product, containing 18 percent P_2O_5 and 15-17 percent MgO, has been used favorably on acid as well as neutral and alkaline soils of California. Permanente Metals Corp. is the first commercial producer of this new type of phosphate fertilizer in the United States; only one or two other concerns have conducted pilot plant operations. Because of the heavy demand for phosphate fertilizers, the product is now distributed only in California.

In describing the use of the new fertilizer, Dr. A. C. Byrns, director of research at Permanente Metals Corp., explained that it can be applied directly to the soil, as is common practice, but that the major proportion is employed in mixed fertilizers combined with potash and nitrogen.

Raw materials for the fertilizer plant consist mainly of raw phosphate rock obtained from Montana and serpentine rock available locally in large quantities. These materials are conveyed to the two electric furnaces, where they are reacted and fused. The furnaces

You'll be hearing more about

AXIVANE* FANS

. . . AERODYNAMICALLY DESIGNED TO ASSURE EFFICIENCY

The air-straightening vanes placed immediately behind the propeller blades on La-Del Fans smooth the flow of air and permit building up high pressures and a uniform, quiet air flow without turbulence. Greater efficiency and economy results, as air can be conveyed faster with less power in La-Del Axivane* designs. Let us show you how La-Del Axivane* Fans can help with your future ventilation problems.

Quiet Operation
Uniform Air Distribution
Peak Efficiency
No Turbulence

LA-DEL FANS
TROLLER DESIGNED

LA-DEL Division
JOY MANUFACTURING CO.
GENERAL OFFICES: HENRY W. OLIVER BUILDING, PITTSBURGH, PA.

Modernized Quarry Operations at Linwood Stone Products Co.

SAVE MONEY IN THESE 2 IMPORTANT WAYS

From Primary Crusher or direct from Quarry is the Double-Duty assignment of this Dixie 50 x 50 inch Hammermill

The Dixie Hammermill in operation at Linwood Stone Products Co., Linwood, Iowa, is often called upon to play an important dual role. In the production of agstone the Dixie is equipped with 1 in. bars. The yield is 200 t. p. h. of minus 1 in. stone of which 80% passes agstone specifications. When an increase is desired in larger sizes the mill is equipped with 2½ in. bars yielding up to 300 t. p. h. of minus 2 in. stone. With the larger cage bars in the mill, *production* can be *stepped up . . . much time saved . . .* by feeding the Dixie Secondary Crusher from 2 sources . . . the primary crusher and . . . direct from the quarry. This is but one of many examples of the ability of a Dixie Hammermill to cut costs and increase output.

Whatever your crushing problem it will pay you to investigate the time and money-saving features of the Dixie Hammermill. Send for your free copy of "More Efficient Crushing of Raw Materials."

DIXIE
MACHINERY MANUFACTURING CO.

4172 Goodfellow Ave.
St. Louis 20, Mo.

Foreign Sales Office:
104 Pearl St., New York, N. Y.

are tapped periodically and the black, neutral molten slag is granulated, dried, ground and sacked for shipment.

Firm Builds Kraft Mill In Northwest

APPROVAL has been received from CPA by St. Regis Paper Co., Tacoma, Wash., for $975,000 of building work in the construction of a $4,135,000 kraft paper mill adjacent to the firm's present plant. To produce 280 tons of bleached and unbleached kraft paper a day, the plant will rely upon the firm's pulp division for raw pulp. Plans are also being made, according to reports, for a multiwall paper bag factory capable of turning out 200 million bags per year for various packaging purposes.

MCA Celebrates Diamond Jubilee in June

THE Manufacturing Chemists Association will celebrate its 75th birthday with a diamond jubilee session on June 4 at Sky Top Lodge, Pa. The one day program will include morning and evening sessions.

Featuring the jubilee will be the presidential address of Charles S. Munson. His presentation of "Then and Now" will contrast early association days seventy-five years ago with today. Other themes include safety, labor relations and chemicals from petroleum.

Renew Contract for Study Of Plastics at Illinois

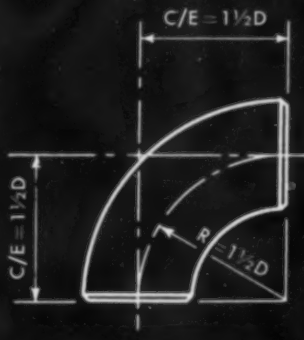
THE College of Engineering of the University of Illinois, and the plastic division of Monsanto Chemical Co. have renewed a contract wherein Monsanto provides funds for a fundamental research program on the dynamic fatigue characteristics of plastics. The research, which is being done under the direction of Prof. William N. Findley of the Department of Theoretical and Applied Mechanics, is intended to provide a better knowledge of the behavior of plastic materials under cyclic stresses, and to aid in choosing the best test methods for use in studying fatigue properties.

USI Buys Baltimore Glycerine Plant

A BALTIMORE, Md., chemical plant constructed by the WPB for experimental production of glycerine from molasses distillery residue has been sold for $90 thousand cash to the U. S. Industrial Chemicals, Inc., the plant's wartime operator. The sale includes

ONLY MIDWEST OFFERS A COMPLETE SELECTION OF 90° WELDING ELBOWS

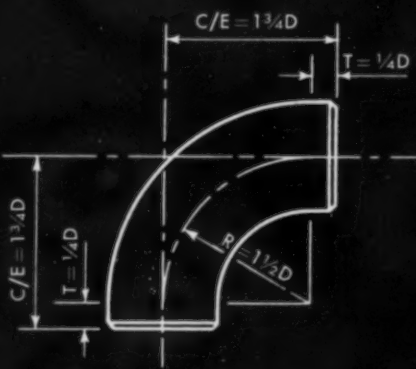
1 LONG RADIUS AMERICAN STANDARD



SIZES: 3/4" TO 12", INCLUSIVE

All dimensions conform to the American Standard for Steel Butt-Welding Fittings ASA B16.9. Unless order specifies otherwise, these "ASA Elbows" will be furnished.

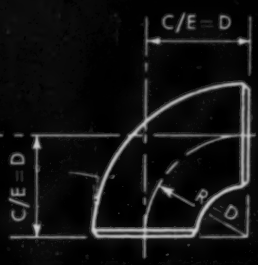
2 LONG RADIUS LONG TANGENT



SIZES: 2" TO 20", INCLUSIVE

Same radius as "ASA Elbows" but with long integral tangent on each end—an exclusive Midwest feature that saves time and pipe, and sometimes eliminates an extra weld.

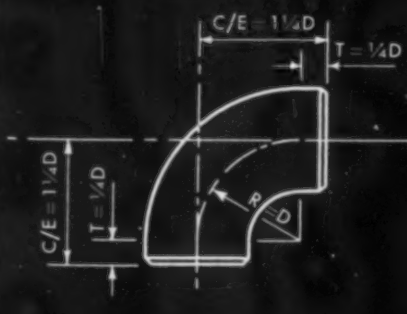
3 SHORT RADIUS



SIZES: 1" TO 12", INCLUSIVE

Where space limitations prevent the use of "ASA Elbows" or Midwest "Long Tangent" Elbows shown at left, these short turn elbows without tangents are recommended.

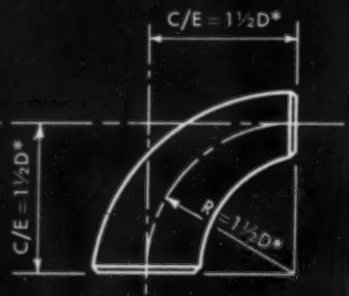
4 SHORT RADIUS LONG TANGENT



SIZES: 14" TO 24", INCLUSIVE

These OD sizes are short radius but have the exclusive Midwest long tangents that save pipe and make it possible to line up the fitting and pipe more quickly and accurately.

5 LONG RADIUS REDUCING



SIZES: 2" TO 12"*, INCLUSIVE

Only Midwest makes the reducing welding elbow which takes the place of a straight elbow and a reducer. It eliminates one weld, cuts installation cost, and reduces pressure drop.

SYMBOLS:

C/E = Center-to-End Dimension
D = Normal Pipe Size
R = Radius
T = Length of Tangent
*D = Dimension is Larger Pipe Size

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS

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PIPING & SUPPLY CO., Inc.
Main Office: 1450 South Second St.
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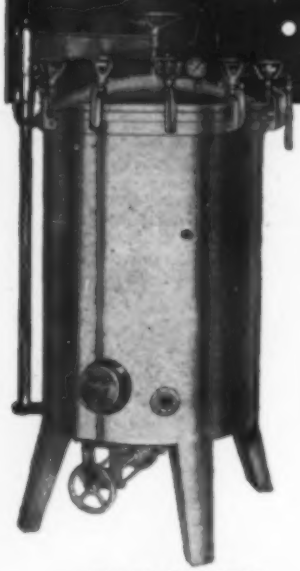
The Heart of a Good Filter is its FILTER LEAVES!

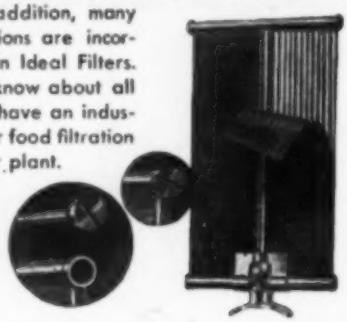
You Can Depend On KLEIN FILTERS and FILTER LEAVES

• Positive Filtration . . . No Clogging
• Full Drainage



Klein Ideal Diatomaceous Earth Filters and the exclusive Klein Filter Leaves, in combination, assure positive filtration at all times. Operation, cleaning and maintenance costs are at a minimum with Klein Filters. In addition, many radical innovations are incorporated in Klein Ideal Filters. You'll want to know about all of these if you have an industrial, chemical or food filtration problem in your plant.

Write for latest Klein Bulletin



Klein Filter Leaf—If damaged, metal cloth easily replaced. No rivets. Note horizontal headers—central duct—Klein Cleanout Cap.

Established 1909

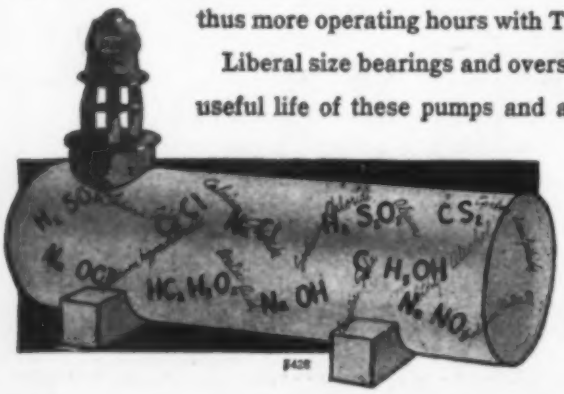
KLEIN FILTER & MANUFACTURING COMPANY
1225-29 School Street • Chicago 13, Ill.

MORE OPERATING HOURS WITH TABER VERTICAL PUMPS

Oleum, concentrated sulphuric, mixed acids and similar liquids, are well within the handling range of Taber Vertical Pumps.

By locating the stuffing box away from fluid being handled, repacking interruptions are reduced to an inconsiderable minimum . . . thus more operating hours with Taber Vertical Pumps.

Liberal size bearings and oversize shafts extend the useful life of these pumps and also retard vibration.



For complete information, please write on your letterhead for

TABER SPECIAL BULLETIN V-837

TABER PUMP CO. • Est. 1859 • 294 ELM ST., BUFFALO 3, N. Y.

TABER PUMPS for Higher Practical Performance

two buildings located at 5101 Distillery Ave., plus items of production equipment which cost the government about $263,435, War Assets Administration said. No land was involved. It is expected that most of the machinery and equipment will have to be discarded either because of obsolescence or deterioration, and no employment estimate has been submitted for the plant's future operation.

READERS' VIEWS and COMMENTS

For the Record

To the Editor:

Sir:—While your recent article on the use of chemical stoneware to handle chlorine (*Chem. Eng.*, March 1947, pp. 216-218) is very interesting, we must take exception to Mr. Herstein's gentle inference that only their special bodies SP-22 and B-41 are suitable for chlorine plant work.

The exact equal of their SP-22 body has also been manufactured by us for something like 20 years. We have on numerous occasions supplied a ceramic body of its exact and identical equal for chlorine plant service. However, our ceramic research department has preferred to offer our newer special heat-shock-resistant stoneware body which is called "Ceratherm 500."

In the case of the General Ceramics Co.'s body B-41, it might be mentioned that we were the first American manufacturers to make a ceramic material into which is incorporated a silicon carbide filler. It is known under our tradename, "Acitherm."

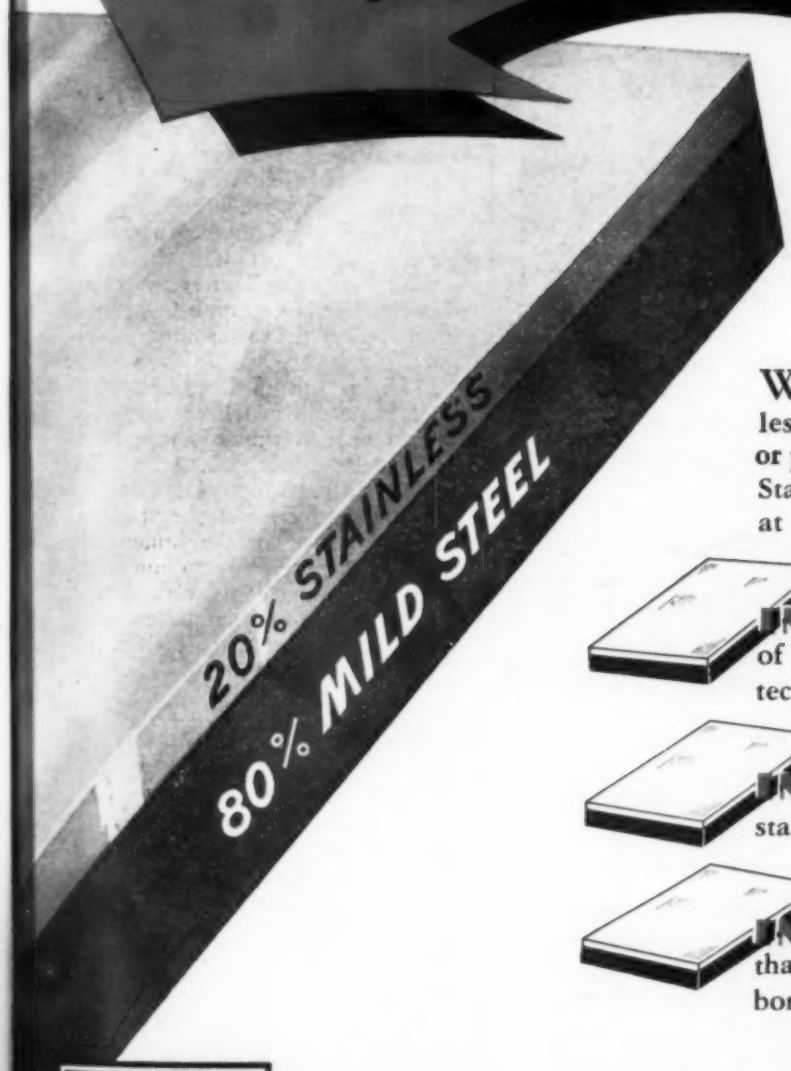
HOWARD FARKAS
Sales Manager
The United States Stoneware Co.
New York, N. Y.

Mr. Herstein Replies

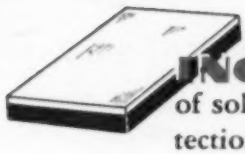
To the Editor:

Sir:—In reply to Mr. Farkas' letter we would like to bring out the following points: (1) It is recognized that other chemical stoneware manufacturers have supplied equipment for chlorine plant service. (2) There is more to the manufacture of ceramic ware for the chemical industry than an approximate duplication of the constituents of bodies that have proved satisfactory. Other requisites no less important are correct technique in body preparation, shaping, drying, and firing. (3) The bodies mentioned in the article, SP-22 and B-41, were chosen for chlorine plant use by the

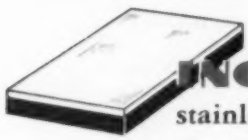
Get TOP PROTECTION at bottom cost!



WHENEVER your plans include stainless steel protection for your products or plant equipment, look to INGACLAD Stainless-Clad Steel for top protection at bottom cost.



INGACLAD, with its 20% cladding of solid stainless steel, gives you 100% protection on the exposed or contact side.



INGACLAD costs much less than solid stainless.

INGACLAD fabricates more easily than solid stainless because of its permanently bonded backing of mild steel.

At present, IngAclad is available only in Sheets and Small Plates.

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. . . another difficult liquid-storage problem solved with acid- and corrosion-resistant Ampco Metal, long a money-saving favorite with process industries

Wine makers in Caracas, Venezuela, watch costs too. That is why they make their wine-storage tanks out of Ampco Metal, the modern aluminum bronze alloy. Money-saving features are: resistance to acids and corrosion; easy cleaning; neater, more compact installations; and preservation of flavor.

These tanks, 8 feet high and 6 feet in diameter, are fabricated from 3/32-inch Ampco Grade 15 rolled sheet. Welding was done by the carbon-arc process, using ⅛-inch Ampco-Trode 10 aluminum bronze electrodes; these electrodes have the same important acid- and corrosion-resistant properties as the parent metal.

Ampco Metal is an engineered aluminum bronze alloy, available in seven grades for countless applications. Not only does it withstand the destructive action of a wide range of caustics and acids, but it also has a number of desirable service qualities not found in other anti-acid metals: High tensile strength. Good ductility. Less weight. Hard enough to resist squashing, wear, impact, fatigue.

Process industries in all parts of the country are using Ampco Metal to solve a wide variety of problems. Send us your troubles, or call in an Ampco field engineer. Write for latest bulletins giving further details.

Ampco Metal, Inc.
Department CE-5, Milwaukee 4, Wis.
Field Offices in Principal Cities

P-18

AMPCO

the metal without an equal

contractors employed by the Chemical Warfare Service for constructing chlorine plants during **the last war.**

We trust that this removes Mr. Farkas' "exception to our gentle inference."

F. E. Herstein

Keasbey, N. J.

Suggestions for Industry

To the Editor:

Sir:—One point which I have been discussing with some of the personnel men who have visited our campus, for example Du Pont, General Electric and American Cyanamid, is as follows: "Industry has the greatest stake in a continuation of good instruction in engineering." There are four directions in which this interest may be manifested:

1. Industrial fellowships to help keep good young graduate students in school until they finish master's or doctor's degree. This is a direct method which has been and is being used considerably to raise the educational level of the engineering profession.

2. Urging qualified graduate students to remain in school until they have completed their doctor's work rather than enticing them away for the immediate high salaries which are being offered for master's men. It is more impressive on the student for the personnel men to urge him to remain and complete his work than it is to try to undo the immediate damage and the impression which is left by many personnel men. They are desperate for personnel, but they would be wise to consider the man now and ask him if it would not be better to consider him later when he has finished his doctorate.

3. Some type of partial support for young instructors through a series of farmed out research projects which would be handled by the young instructor and which would allow him to increase his earnings and still stay in the teaching profession. This is done for the older men who have achieved some prominence in their fields and who have become industrial consultants along with their academic work, but very seldom is it the practice to offer such additional remuneration to the younger men whom we are trying to attract into the teaching profession.

4. Help through various association "lobbies" and other means to get the budgets and salaries raised by state legislators. This is a rather ticklish question but one in which industry can be of much aid if it is handled properly and smartly.

Worried Prof.

Measure Your Packaging Operation by BAGPAKER Standards!

completely automatic!

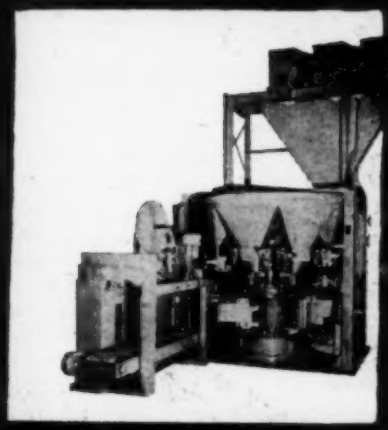
ALL BAGPAKERS MAKE THIS FAMOUS "CUSHION STITCH"

Taped closure is Moisture-Resistant—Sift-Proof—Insect-Proof

The economical **BAGPAKER** operation includes two important features:

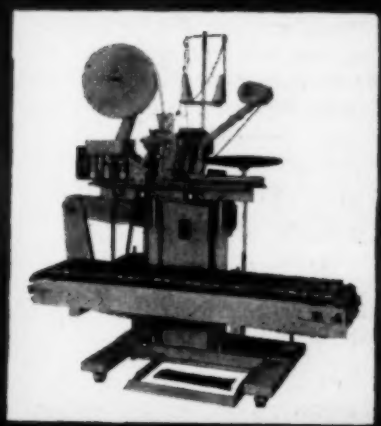
1. Tough **BAGPAK** open-mouth multi-wall paper bags.
2. The "cushion-stitch" closure that's just as insect-proof, sift-proof and moisture-resistant as the high grade open-mouth **BAGPAK** bag itself.

Call in a **BAGPAK** *engineer today . . . let him measure your present packaging operation against low-cost, speedy* **BAGPAKER** *performance.*



MODEL "A" — Completely automatic—extremely accurate weighing. Saves on "give away" material, labor and bag costs, thus paying for itself quickly. Machine capable of filling and closing 100-lb. bags at the rate of 15 per minute . . . needs one operator.

6 to 12 bags a minute!



MODEL "DA" (Portable and built to last)—One operator filling and closing, can handle 2 to 4 100-lb. bags a minute . . . 6 to 12 a minute where filled bags are delivered to BAGPAKER conveyor (quickly adjustable for various bag sizes). Starting and stopping of sewing operation is automatic . . . no tape wasted.

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NEWS FROM ABROAD

Special Correspondence

FAVORABLE OUTLOOK FOR PRODUCTION OF COAL-TAR DERIVATIVES AT BRITISH COKE PLANTS

Special Correspondence

DURING APRIL deliveries of most chemicals to home consumers remained below normal, but coal reached factories in larger tonnages, and production consequently is not unsatisfactory. Several months must elapse before the effects of the fuel crisis are wiped out. The coal and power position looks less unsettled and more promising than industrialists dared to hope a few months ago. Seasonal drop of coal stocks in March-April was avoided this year, and the change-over to a five-day working week in the mines will not affect overall output if absenteeism diminishes in proportion. The Minister of Fuel has set up a revised though "unofficial" production target of 220,000,000 long tons which compared with 200,000,000 tons demanded by the National Coal Board some months ago. While deliveries to chemical works have increased, the industry is ignorant of what to expect in the long run, and also of its steel quota for new plant. Shortage of coal and steel remains the British chemical industry's headache No. 1.

Gas production will be aided by erection of new works authorized by the Ministry of Fuel. One of the largest will be in West Yorkshire. The first unit, with a capacity of 7,000,000 cu.ft. a day, is scheduled to cost £1,250,000. When a second unit of similar size is in operation, the plant will produce 550 tons of smokeless fuel and 50 tons of coal-tar in addition to 14,000,000 cu.ft. of gas. Another plant, capable of a daily output of 8,000,000 cu.ft., has been sold to a private company from government surplus stocks; during the war it served as an emergency gas source for Sheffield steelworks. While authorities show interest in extending gas production, other branches of the carbonization industry are perforce neglected. It has been found impossible, for instance, to allocate more coal for low-temperature carbonization because this process, though yielding valuable byproducts, does not produce sufficient gas.

On the other hand, official support is given to developments which promise to cut consumption of coal in gasworks. Oil injection was used during the winter to enhance calorific value of gas. This method, it is now certain, will find a permanent place in British gasworks practice. In one plant in north-west England coke obtained as byproduct in gas production from coal is used in water gas generators and producer gas plants to make a lean gas, and this is enriched by injection of oil with such success that the resulting gas is well above the minimum standard specified.

By comparatively small changes in plant outlay, including new oil pumps and delivery lines, it has been possible to produce rich carburetted water gas. By this means an increase in gas production by fully one-quarter has been obtained over the past five years in one big gasworks, while the amount of coal carbonized rose by 1¼ percent only. Experiments are under way to obtain a gas of extra-high calorific value by injection of oil and to adapt the injection process to horizontal coal gas retorts.

More Coal-Tar Products

From the point of view of the chemical industry these advances are of interest because concentration on bigger gas output last winter necessarily affected the yield of byproducts. The new methods of coal economy promise to add to the production of coal-tar, ammonia, benzol and other byproducts, for if coke can be used for gas making as well as for its traditional uses, the coke-oven industry which always attached more importance to byproduct recovery than gasworks, will be able to expand. Plans for extension of the coal distilling industry are prepared in various parts of the country. A scheme for Lanarkshire, Scotland, provides for erection of five or six linked carbonization plants, the first of which is to be erected on a redundant industrial site at a cost of £250,000-300,000.

Biggest new enterprise announced in the chemical industry this month concerns production of solvents and plastics. Distillers Co., which has shown growing interest in chemical activities, are responsible. The company which is one of Britain's penicillin producers and last year acquired an interest in the British Geon Ltd. intends to spend £2,000,000 on the works at Salt End, Hull, of one of its subsidiaries, British Industrial Solvents Ltd., which it has brought under exclusive control by buying the German-owned interest from the Custodian of Enemy Property. The expansion scheme was necessitated by increased consumption of solvents, plasticizers and acetic acid and anhydride in the plastics, rayon, fine chemical and dyestuffs industries. Second expansion scheme concerns British Resin Products Ltd., another Distillers' subsidiary, which will erect a factory at Barry, South Wales, to cost £1,250,000. It is in this district that the British Geon Ltd., in which Distillers hold a 55 percent interest, is erecting its new factory. The two plants will be interdependent.

It is noteworthy that some of the biggest chemical ventures launched during the past 12 months have been by companies primarily interested in the chemical industry as suppliers of raw materials or buyers of finished products. The plastics enterprise of Celanese, the participation in the big nylon plant by Courtaulds, the plans for the production of hydrocarbon chemicals announced by Shell and another oil refinery company, and other schemes of a similar nature indicate the opportunities of the chemical industry are attracting attention in other trades.

While these enterprises take a long time to mature, specialist chemical firms are getting on with modernization and expansion plans. Unfortunately these are in many cases held up by delivery delays due to the steel shortage. Nevertheless many smaller projects started after the war will bear fruit this year. Increased capacity is urgently needed, for the fuel shortage during the winter has obscured but not removed the fact that many manufacturers are operating at or near full capacity and need more plant to satisfy their customers.

A struggle on the 30 YARD LINE!

If these two largest fighters in the world had fought it out on a football field, the struggle could have been staged inside one of the two largest thickeners in the world.

Their bones now mingle with those of millions of marine animals to make up the almost inexhaustible deposit of pebble phosphate in the "Billion Dollar Valley of Bones" in Florida.

Two General American Thickeners, 383 feet in diameter, in addition to eleven other General American Thickener and Hydroseparator Units, will form an integral part of the equipment installed to assist International Minerals and Chemicals Corporation to increase their production of high grade phosphates for industry and agriculture.

OTHER GENERAL AMERICAN PRODUCTS

Dryers	Kilns	Evaporators
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The many uses of "Virginia" Zinc Sulfate include chemical and pharmaceutical manufacturing, electroplating, glue and adhesives, paint trades, rayon and plastics manufacturing, metallurgical and agricultural applications. It is an exceptionally pure, 89 per cent granular, free-flowing crystal, and is quickly and completely soluble in water . . . zinc content, 36 per cent. Shipped in 100 lb. bags and 400 lb. barrels.

It may well be that "Virginia" Zinc Sulfate can play an important part in perfecting your processes. Our Research Department will be glad to survey your needs for possible applications. Call upon us freely. VIRGINIA SMELTING COMPANY, West Norfolk, Virginia.

VIRGINIA *Chemicals*

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SODIUM HYDROSULPHITE • ZINC HYDROSULPHITE
ZINC SULFATE

WEST NORFOLK • NEW YORK • BOSTON • DETROIT

Norwegian Wood Pulp Sold for First Half of This Year

MOST Norwegian wood pulp producers have disposed of their expected output for the first six months of 1947. The demand is brisk, even for delivery during second half of the year. Unfortunately the Norwegian pulpwood situation is difficult, and it is rather uncertain what quantity will be available for the mills during the season, so most cellulose mills expect they shall only be able to run at 30 to 40 percent of their capacity. Norwegian pulp mills will not be in a position to ship much to the U. S. in 1947—except for "token" shipments.

Moist mechanical pulp is quoted at about $30 to $33.80 per 1,000 kilos 50 percent airdry basis f.o.b. for ordinary news quality, and fineground about $34 to $36. Only very limited quantities remain unsold for first half of 1947, and several contracts have been closed for second half of next year.

Activated Carbon Will Be Produced in Cochin

A FOOTNOTE to the vast potential of the chemical industry in India is contained in the organization of Cochin Chemical Industries Ltd., recently at Ernakulam, in Cochin State, South India. With an authorized capitalization of $300,000, of which only $150,000 is being issued now, the firm plans to go into the manufacture of activated carbon from coconut shells, aiming at the 4,000-ton present demand for the substance among sugar refining and vegetable oil plants.

Figuring on an initial capacity of about 500 tons of activated carbon annually, plus such byproducts as acetic acid, acetone and methyl alcohol, the concern states that "conservative estimates" based on careful price-cost studies show it can show a net profit of $54,000 annually—or better than 30 percent on the initial investment.

Congress and Exhibition To Be Held in Liege, Belgium

COINCIDING with the Centenary of the University of Liege, a congress and exhibition will be held in Liege on August 30 and continue through September 13. The congress is entitled "Past, Present and Future of Our Industry" and an invitation is extended to engineers and industrialists from all countries to attend. The exhibition is entitled "International Exhibition of Scientific Research and Industrial Control" and will be held in the three Institutes of the Faculty of Applied Sciences.

Adaptioneering AT WORK

From candy bars to ceramics, from celanese to soft drinks, all have processing problems to be solved by Sprout-Waldron ADAPTIONEERING.

A nationally known manufacturer of chocolate candy bars had to remove **all** the stones from the almonds going into his product. Easy, you say? Here's the rub—the stones were often the same weight as the almonds . . . often the same size as the almonds. Many procedures had been tried but were not satisfactory. Then, Sprout-Waldron ADAPTIONEERING produced the answer. First the beans were separated by running them over inclined screens of the Perfect Circle type into four different size classifications. Then each of these sized classifications was put through an exceptionally efficient "air leg" where the stones were removed by variations in specific gravity.

Both the screens and the "air legs" were tied together in one frame. The result . . . a compact single installation capable of performing an operation heretofore thought possible only by using a whole series of machines.

If your process involves size reduction, mixing or blending, size separation or classification, or the handling of materials in bulk, you may realize considerable savings by consulting Sprout-Waldron. Our valuable ADAPTIONEERING service—ingenuity + machines + experience—is at your command.

SPROUT-WALDRON & CO.

Manufacturing Engineers

MUNCY **PENNSYLVANIA**

FOR FASTER MIXING WITHOUT AERATION

Cut shows a 1 HP Eppenbach Homo-Mixer processing entire contents of open-end 55 gallon drum at 7,000 RPM without vibration or splashing.

Mixing tank requires no cover because this mixer will not produce a vortex or other excessive turbulence on the surface.

Units designed up to 25 HP for mixing all types of free-flowing liquids.

The Eppenbach Homo-Mixer is unlike any known batch mixing device. The design permits far higher speeds than are practicable with any propeller or blade-type agitator. Proportional increase in hourly capacity may be easily attained, together with qualitative improvement of resulting mixture.

If you are not already familiar with this unique portable agitator, write for a copy of Catalog No. 402. No cost, no obligation.

EPPENBACH, Inc.
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Eppenbach

AUSTRALIAN CHEMICAL INDUSTRY, EXPANDED IN WAR YEARS, IS BEING FURTHER INCREASED

McGraw-Hill World News Bureau

TWENTY-YEAR old Anglo-American rivalries in the Australian organic chemical market, recently intensified by American branch plants down under, were brought to a new climax as ICIANZ (Imperial Chemical Industries of Australia and New Zealand) announced that plants for production of urea formaldehyde molding powders, of methoxone and gammexane have been completed and that a polyvinyl chloride plant is going up at Botany, New South Wales. Current plans also include doubling of the output of the Osborne alkali plant from an undisclosed base capacity.

Before ICIANZ ever thought of clearing plant control panels for action against Germany's and Japan's chemical industrial might, a friendlier kind of warfare seemed closer at hand. Between the two wars ICIANZ executives had been losing sleep over disconcerting reports of American chemical industrial expansions in the Pacific area, both through trade penetration and establishment of branch plants everywhere.

To meet this challenge, which was much more formidable than the post-1918 German onslaught on the world's chemical markets, ICIANZ mapped out a leisurely but comprehensive expansion plan which would keep its production in Australia ahead of all competitors, in volume as well as variety. This long-term expansion plan was telescoped into a few years when dependence on the parent concern in England was shaken by the break of war in Europe, and the telescope was given another push when Japan struck late in 1941.

An alkali plant had been under construction since 1935 at Osborne. There was no reason to rush the job because American expansion was weakest in the alkali field and Japanese trade competition in soda products was only beginning to look up. But in the fall of 1939 British capacity for crowding half a day's job into the last twenty minutes triumphed over fast-worsening equipment delivery schedules. Plans were revamped to meet greatly increased demands, and the plant went into operation in 1940. Its capacity for alkali products, now to be doubled, is still ICIANZ's jealously guarded secret.

SYNTRON

"Vibra-Flow"

VIBRATORY FEEDERS

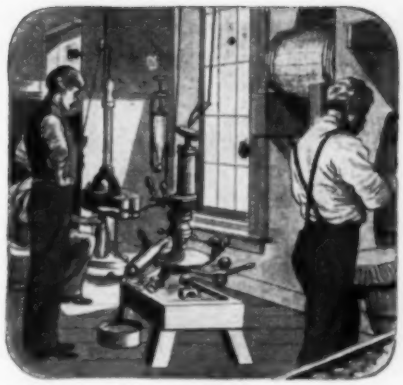
Speed Up Material Handling

—by their ability to handle bulk materials, from light, fine powders to heavy, coarse ores — hot or cold — dry or damp.
—by providing rheostat control of rate of flow to meet the capacities of dryers, screens, crushers, belt conveyors, etc.

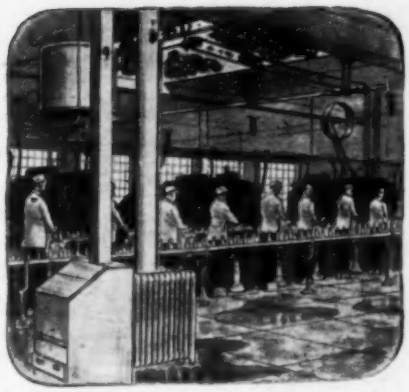
Write for illustrated folder

SYNTRON CO., 610 Lexington, Homer City, Pa.

1 **1785**—Townsend Speakman, druggist, at the suggestion of one Dr. Physick, produced an artificially carbonated water for its health value. Soon, fruit juices were added for flavor and the soft drink business was under way in America.

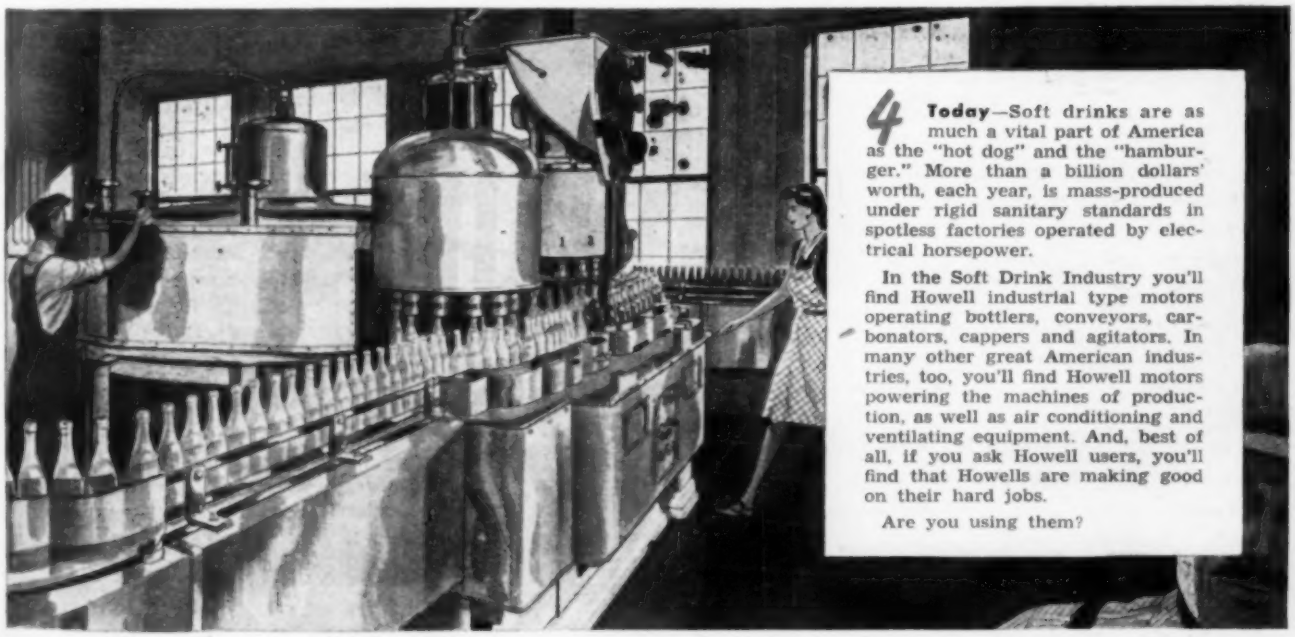


2 **1880**—Bottling machines looked like this. Work was mostly by hand in crude workshops. People went for the new "pop", not only as a beverage, but as a "cure" for gout and many other ailments. New methods were still to come.



3 **1915**—Howell engineers began working with machinery manufacturers to apply industrial type motors, specially designed, for the particular applications in bottling. Soon Howell "Red Band" Motors appeared in this and many other industries.

Then, "Pop" became a billion dollar business!

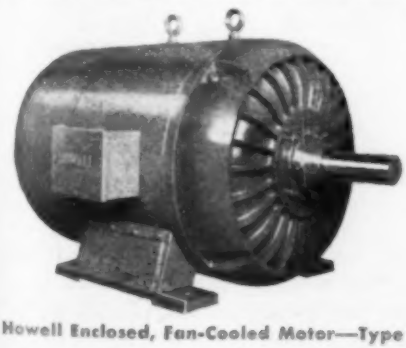


4 **Today**—Soft drinks are as much a vital part of America as the "hot dog" and the "hamburger." More than a billion dollars' worth, each year, is mass-produced under rigid sanitary standards in spotless factories operated by electrical horsepower.

In the Soft Drink Industry you'll find Howell industrial type motors operating bottlers, conveyors, carbonators, cappers and agitators. In many other great American industries, too, you'll find Howell motors powering the machines of production, as well as air conditioning and ventilating equipment. And, best of all, if you ask Howell users, you'll find that Howells are making good on their hard jobs.

Are you using them?

Be wise—buy industrial type Howell Motors! They're designed for the toughest operating conditions in industry; consequently, they perform better on *all jobs!*



Howell Enclosed, Fan-Cooled Motor—Type K

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Manufacturers of Quality Industrial Type Motors Since 1915

MARTIN CALCINER / PREHEATER

PROVIDES FOR RABBLING MATERIAL IN ATMOSPHERE TEMPERATURE UP TO 2500°F

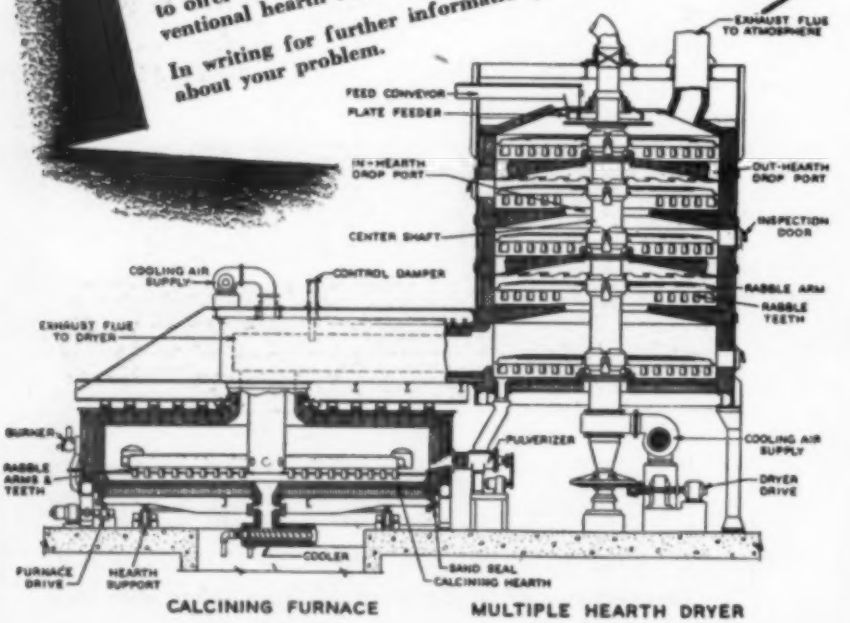
The conventional multiple hearth furnace is limited to temperatures of 1800° to 2000°F due to unavoidable conditions in which the fire brick hearths are subjected to heat from both sides.

By contrast, the calciner section of the Martin Furnace is designed to handle temperatures up to 2500°F. It's a single chamber furnace in which the brickwork can allow very high temperatures with durability and heating efficiency corresponding to other chamber type furnaces. It also has a rotating hearth in combination with a stationary rabbling device which provides for continuous operation in a most uniform manner without creating hot spots in the material bed. The stirring device is, of course, insulated and cooled internally.

The waste heat from the calciner is used to dry and/or preheat the material feeding the calciner.

If you have any calcining or roasting job which requires a temperature ranging between 1800° and 2500°F you should investigate the Martin Calciner/Preheater. If your process calls for lower temperatures, the multiple hearth section alone with its revolving rabble arms and fixed hearth has several things to offer which are great improvements over the conventional hearth furnaces.

In writing for further information, tell us in detail about your problem.



CALCINING FURNACE MULTIPLE HEARTH DRYER

Martin Furnace Division

MORSE BOULGER DESTRUCTOR CO.

211-0 East 42nd Street New York 17, N. Y.

At Deer Park, Victoria, a synthetic ammonia plant operating on the Haber principle went into production in 1940, and the Nobel black powder plant at Deer Park was enlarged to produce special explosives. Four nitrogen fixation plants—at Ballarat, Villawood, Mulwala and Albion—subsequently were built on government account. These government-financed ventures laid the technical basis for postwar production of ammonium sulphate, formalin and methanol. Wartime researches into the use of Australian hardwood timbers in the production of charcoal for explosives made the Nobel branch independent of imported charcoal. Another significant development associated with Deer Park is the first Australian attempt at producing tetryl. ICIANZ later was asked to build several plants on similar lines for government arsenals.

Nitrating Units

Before the war, ICIANZ's Fabrex plant had been concerned with nothing more serious than the nitration of cellulose, with leather-cloth as end product. Other nitrating units erected during the war pushed the scope of products from nitrobenzene to paranitrochlorbenzene and phenacetin. Nitrobenzene was catalytically reduced to analine by using hydrogen from the caustic chlorine cells at Yarraville. Aniline was used at Yarraville in turn to produce dimethyl aniline and diphenylamine, and these provided the intermediates for production of phenothiazine, neozone and a variety of rubber chemicals at Botany. At Yarraville, production of chlorine was raised from 1,000 tons prewar to 2,300 tons by 1942, with a corresponding gain in caustic soda.

DDT's firm establishment as a substitute for Japanese pyrethrum insecticides called for establishment of a plant to produce monochlorbenzene as an intermediate in the synthesis of this product. DDT has been in production since 1943. Construction of a plant at Yarraville for production of aniline by the vapor phase process went under way in 1942, and production commenced in 1944. This plant, with a reputed capacity 1,000 tons per year, is the only one of its type in Australia. The Yarraville diphenylamine plant, like the aniline plant, makes use of a continuous vapor phase reaction in the presence of a catalyst instead of the conventional high pressure phase batch process.

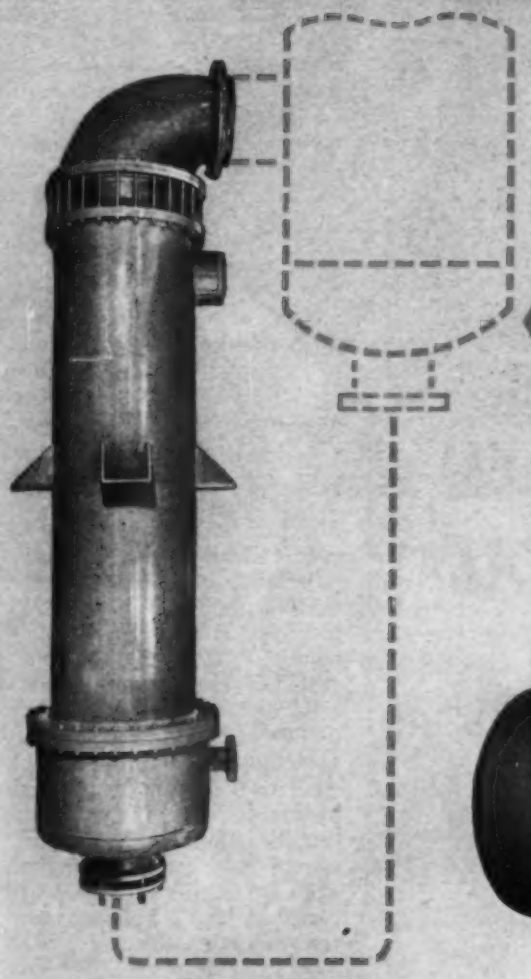
Perhaps ICIANZ's biggest undertaking during the war years outside the government-financed but ICIANZ-managed munitions annexes was the construction of the £1-million electrolytic soda plant at Matraville, near

STRUTHERS WELLS

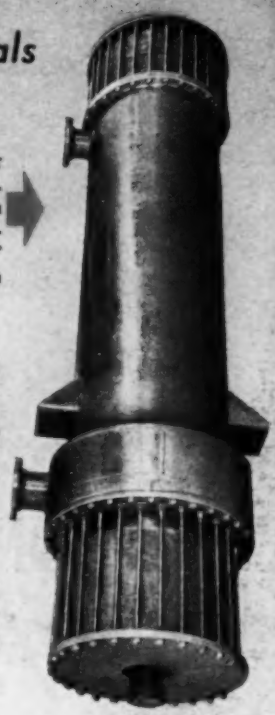
heat transfer EQUIPMENT

For Acids and Other Corrosive Services

Built from Alloys and Non-Metallic Materials

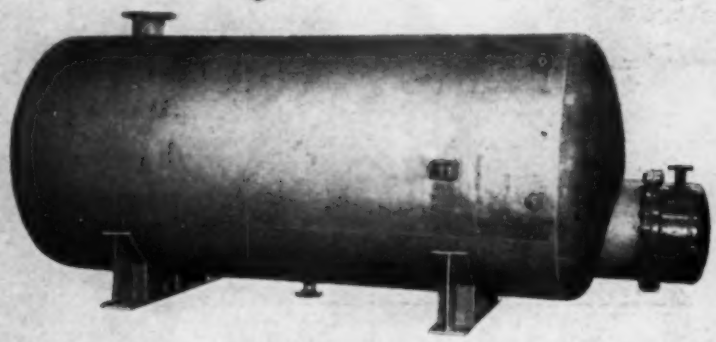


A 28" diameter cooler-absorber for hydrochloric acid service. Floating head construction with tube bundle of "Karbate" impervious graphite, heads of "Haveg," and parts not in contact with vapors of steel.



Vertical calandria for sulfuric acid concentration, replacing equipment which failed due to corrosion. One of a large number of duplicate units supplied. Full floating head construction, "Karbate" tube bundle, cast alloy top head.

A reboiler of 316 stainless alloy, stress relieved and water quenched. Unexcelled facilities for special alloy work in any sizes which can be shipped.



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Continental Screw Conveyors and Elevators handling material to storage and from storage to mill.

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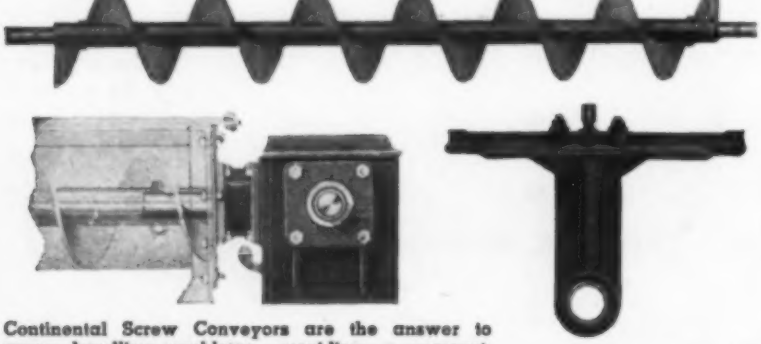

Continental Screw Conveyors are the answer to many handling problems, providing a compact, efficient, economical unit for handling many materials. They require a minimum of space, operate on any plane, can receive or discharge materials at various points, and can be made dust-tight.

In planning your Screw Conveyor system, specify Continental Helicoid, Sectional or Ribbon Conveyor, Hangers, Box Ends, Conveyor Trough, Vertical Screw Elevators. Also Manufacturers of Belt Conveyors and Bucket Elevators.

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CONTINENTAL GIN COMPANY

BIRMINGHAM, ALABAMA

CGC ATLANTA • DALLAS • MEMPHIS CGC

Sydney, known as Botany plant. Its capacity, again, is every competitor's guess.

In conjunction with Albright & Wilson Ltd., of England, ICIANZ built a factory to produce phosphorus, phosphoric acid and food phosphates. In view of these widespread activities it is odd that ICIANZ's attempts at establishing coal-tar derivatives as an industry lacked push and imagination. In association with Broken Hill Pty. Ltd. (Australia's U. S. Steel) a small plant was built to utilize certain coke-oven byproducts, but apparently it never got beyond phthalic anhydride and betanaphtol.

During the war years the technical aspects of plant construction also underwent a remarkable change. From assembly of foreign-designed and foreign-fabricated plant ICIANZ proceeded to having standard designs executed by local iron works, and ultimately one plant, it is claimed, was entirely redesigned when a unit based on British specifications was giving trouble.

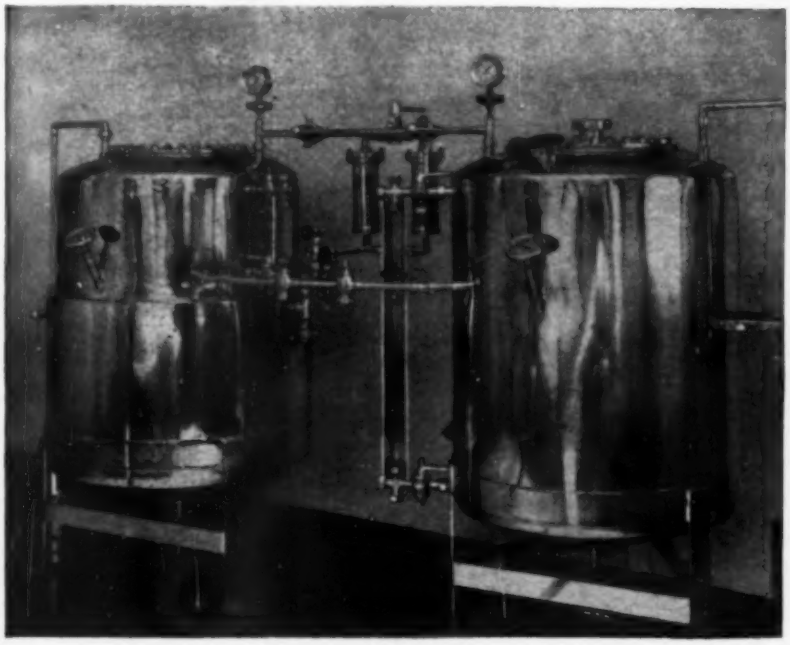
After a lapse of nine years Melbourne recently had its first postwar "Chemex." The exhibition was sponsored by the Australian Chemical Institute and the Australian Society of Instrument Technology. About 60 firms and government organizations represented with exhibits.

A folder distributed by the Ministry for Postwar Reconstruction at "Chemex" lists a number of chemicals which are not yet produced in Australia even though they are consumed in substantial quantities. The list includes barium salts, bleaching powder, bromine and bromides, cadmium lithopone, activated carbon, carbon black, ethyl benzene, freon, formic acid, gylcols, iodine and iodides, lithopone, oxalic acid, photographic reducing agents, potassium carbonate, potassium chlorate, potassium cyanide, potassium hydroxide, potassium permanganate, metallic sodium, sodium cyanide, ultramarine blue, urea, and synthetic dyestuffs. A similar list would have contained at least a hundred more items ten years ago.

Large Scale Drug Industry Planned in India

TATA SONS LTD., Indian industrial heavyweight, has a new interest—and India has a newcomer to the growing ranks of her drug and pharmaceutical manufacturers. Investa Industrial Corp. Ltd., a Tata subsidiary, has just completed arrangements with the princely state of Kashmir, on India's northern border, for the establishment of a large scale drug industry based on Kashmir's abundant crops of such raw

REPUBLIC *Enduro* STAINLESS STEEL



Protects Product Quality

Absolute sanitation is a "must" requirement in this pure yeast culture apparatus, made of lustrous, easy-to-clean Republic ENDURO Stainless Steel. Other ENDURO applications include autoclaves, condensers, heat exchangers, valves, kettles and tubing.

Cleanliness . . . sanitation . . . freedom from contamination . . . all three are vitally important in many different branches of the chemical process industries. That's why more and more processing equipment designers and buyers everywhere are specifying that their equipment be made of Republic ENDURO Stainless Steel.

ENDURO is inherently sanitary because it is a highly resistant material, has no effect upon quality or purity of most chemical and pharmaceutical products, and is not affected by them. Its smooth, pore-free surfaces offer no foothold for contaminating particles, and it is easy to clean and to keep clean.

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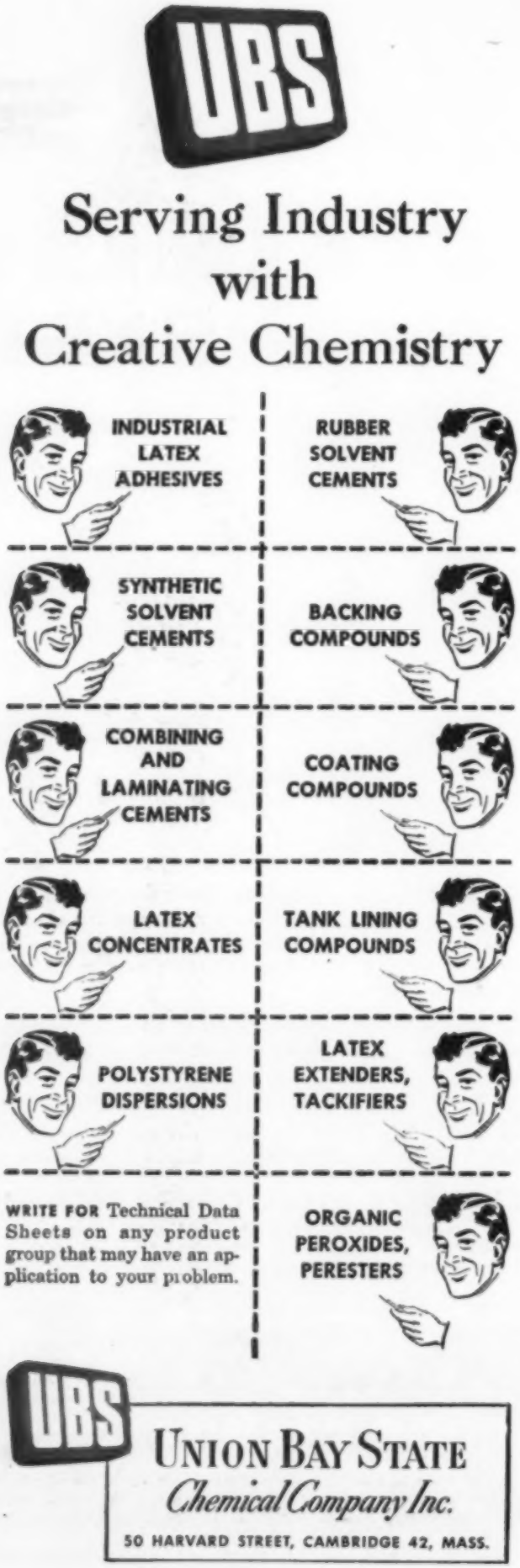


drugs as belladonna, digitalis, valerian, podophyllum, etc.

Investa will be the managing firm for the new and yet un-named company which is to have an authorized capitalization of more than $3,000,000. One of the immediate steps will be a great expansion of manufacture of pyrethrum products, already being made at a State-owned pilot plant, in order to meet India's great demand for insecticides.

Soda Ash Shortage Curtails Mexican Glass Outputs

CONSUMPTION of soda ash by the four principal glass producers in Mexico averages about 4,000 metric tons a month. The Department of Commerce reports that these plants were receiving 3,500 tons a month until September 1946 when shipments from the United States were reduced to 1,250 tons and last December they were cut to 1,000 tons a month. As a result of the drop in ash supplies, glass production has been cut and from present indications will be reduced sharply for the year.

Modern Cyclotron Laboratory For Swedish University

THE Physico-Chemical Institute at the University of Upsala, Sweden, the head of which is the Nobel prize winner Prof. The Svedberg, will shortly be equipped with a modern cyclotron laboratory. Construction already has begun. This plant will, as many other Swedish research institutions established in recent years, be financed jointly by private industry and by the Swedish Government. It is estimated to cost about 2,500,000 kronor ($694,000) of which about 2,000,000 kronor has been granted by the Werner textile concern, of Gothenburg. In addition, various Swedish enterprises building and equipping the laboratory are doing so at cost prices. It is calculated to be completed in 1948.

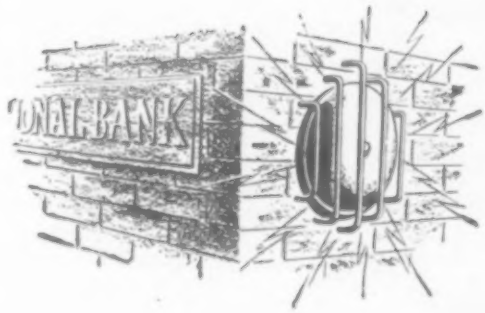
Netherlands Produces Larger Part of Chemical Needs

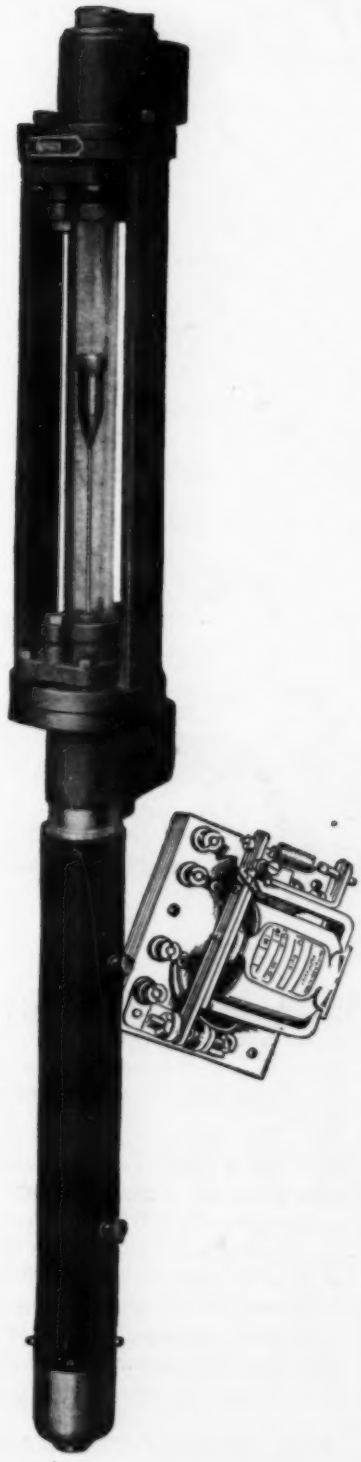
IN A report from Amsterdam the McGraw-Hill World News Bureau says the Netherlands chemical industry is in the process of considerable development and, in several lines, is making use of the opportunity for expansion presented by the elimination of Germany from the field. At present nearly 30,000 workers are employed in the industry as compared with 32,000 in 1939.

The prewar value of Netherlands chemical production amounted to

an ƒk "reason why"

sounds off





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Gives warning, too . . .
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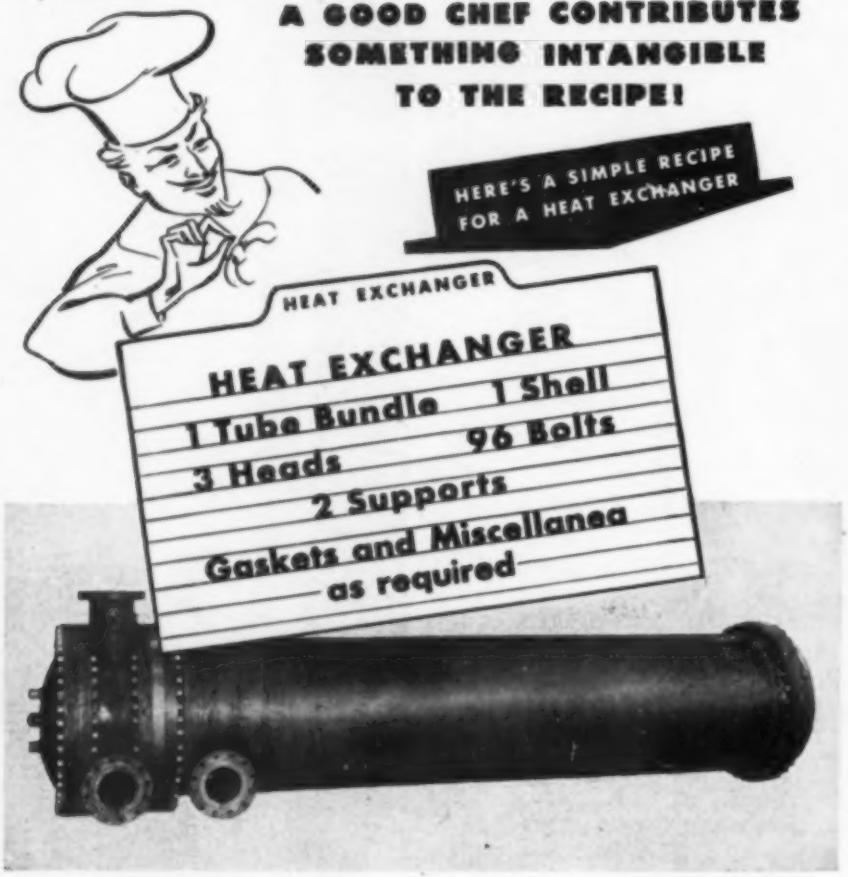
HERE'S A SIMPLE RECIPE FOR A HEAT EXCHANGER
HEAT EXCHANGER
HEAT EXCHANGER
1 Tube Bundle 1 Shell
3 Heads 96 Bolts
2 Supports
Gaskets and Miscellanea as required

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230,000,000 guilders or 20 percent of the total national industrial output, with superphosphate and sulphuric acid leading, followed by the nitrate fertilizer, soap, dye, and paint industries. Although this sequence has been somewhat changed now owing to the difficulties in obtaining raw materials, especially in the soap and paint industries, it is important nonetheless that, whereas the prewar relationship of chemical import and export values was 1.8 to one, it is now one to one. Principal exports are essences, linoleum, household salt, paints and pharmaceuticals, going largely to Belgium, Sweden, Switzerland, Norway and Great Britain.

Favorable developments are reported by the carbide industry, and there are good prospects for the Dutch dye industry superseding the German dye industry. Considerable attention also centers on coal-tar as the basis for new enterprises and on further development of plastics and pharmaceuticals.

The situation of the soap industry is less favorable; out of 152 soap factories only 90 are in operation, mainly because of the shortage of fatty acids. Although the output of shaving soap is 180 percent of prewar, production of other soaps ranges between 23 and 45 percent. Netherlands soap rations allow only 50 percent of prewar consumption. As for fertilizers, production of nitrates covers domestic needs for 30 to 40 percent and phosphates for 90 percent, while potash is still mainly imported.

Brazil Seeks To Develop Fertilizer Materials

LACK of sufficient supplies of fertilizers has become of increasing concern to the government of Brazil. At least four new projects for the manufacture of fertilizer materials are planned. One contemplates the use of phosphate rock from Morocco and another will use domestic rock. The other two have no specific mineral arrangements. Discovery of a large deposit of high-grade apatite near Araxa has been reported and may prove a valuable source of supply.

Norwegian Whale-Oil Plants Report Large Production

ACCORDING to a compilation of reports from seven floating factories and one land station, Norwegian whale-oil production had reached a total of 575,718 barrels or nearly 96,000 metric tons at the beginning of March. Production for the season which ended April 7, is estimated at 850,000 barrels or more

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For a small, tough, hard-working turbine that will go anywhere and do all you expect of it . . . get a Coppus "Blue Ribbon" Steam Turbine.

Coppus Steam Turbines come in six frame sizes from 150 HP down to fractional—so you can match more closely your job requirements. Each smaller size is priced correspondingly less, so by selecting "horsepower" instead of "elephant power" you save on investment and installation cost.

Many well-known manufacturers install Coppus "Blue Ribbon" Steam Turbines on original equipment. They know Coppus quality will protect the reputation of their own products. The Coppus Turbine is also being used on many U. S. Destroyer Escorts, all Casablanca class aircraft carriers and 90% of all Landing Ship Docks.

Like all Coppus "Blue Ribbon" products (blowers, ventilators, gas burners, etc.), the Coppus Steam Turbine is a precision-made product, with accuracy controlled by Johansson size blocks. Every turbine is dynamometer-tested before shipment.

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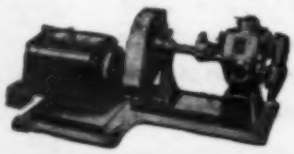

VIKING Pump COMPANY
CEDAR FALLS IOWA

than 140,000 metric tons. In the 1945-46 season, production was 518,842 barrels or 86,400 metric tons. The high prices which have ruled raise total value for last season's output to a record level.

Atomic Committee Formed For Research in Norway

To COORDINATE Norwegian atomic research a 14-man atomic committee was recently appointed by the Norwegian Technical Research Council. The group will be headed by Prof. Svein Rosseland and will include representatives from the two Norwegian Universities, the Norwegian Institute of Technology, and from private industry. Primary task of the all-civilian committee will be to plan a research program and apportion projects in the atomic research field. According to Oslo reports, two 3,000,000 volt high-tension generators are already under construction. One of these will be installed at the University of Oslo and the other at the Norwegian Institute of Technology at Trondheim. Expansion of nuclear physics study at both Oslo and Trondheim is indicated. It is further reported that Prof. Lise Meitner of the Nobel Institute, Stockholm, and Prof. Eduardo Amaldi of the University of Rome will accept chairs as guest lecturers in nuclear physics at the Trondheim Institute.

New Plant Produces Sulphate Of Ammonia in India

TRIAL tests were due to get underway during February at the Fertilizers & Chemicals Travancore, Ltd. ammonium sulphate plant at Alwaye, in Travancore State, India, and first deliveries were scheduled for March. Built by the Intercontinent Corp. of New York for a combine dominated by the Travancore State Government at a cost of nearly $6,000,000 the plant's 50,000-ton annual capacity is said to make it the second largest of its kind in the world It will have a surplus of 17 tons of sulphuric acid daily, plus such byproducts as calcium carbonate, cement quality gypsum, wood-tar and distillation products. Delivery of acid was scheduled for February.

New Chemical Laboratory Building in India

B. G. KHER, Prime Minister of the Province of Bombay, India, laid the foundation stone of the National Chemical Laboratory at Poona on

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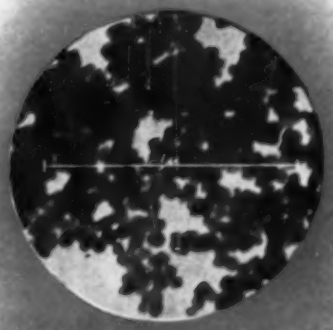

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Newark Wire Cloth COMPANY

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April 6. It is the fifth in the chain of seven laboratories planned by the Indian Council of Scientific and Industrial Research. The first four national laboratories, work on which has already been started, are the Central Glass and Ceramic Research Institute in Calcutta, the Fuel Research Institute, Dhanbad, the National Metallurgical Laboratory, Jamshedpur, and the National Physical Laboratory, New Delhi.

Mr. Kher described the National Chemical Laboratory as "a symbol of our future greatness as a nation" and asked the Indian industrialists to shoulder the major part of the financial and other responsibilities with the government. Promotion of industrial chemistry and the utilization of India's raw material resources through fundamental and applied research are the main objects of the laboratory. An area of nearly 430 acres has been acquired for the laboratory. The cost of building and equipment is estimated at $1,050,000.

Foreign News Briefs

With China's paper, chemical and fertilizer industries facing an acute shortage of sulphur, the National Resources Commission has begun mining iron pyrite at Ma An Shan, Kiangsu Province. Daily production amounts to 120 tons of ore with a sulphur content just above 40 percent. NRC expects to increase output to 300 tons within a few months.

Research on atomic energy will be started by the Academia Sinica Peiping, China, this summer. Dr. Chien San-chiang and his wife Ho Tse-wei, prominent Chinese scientists who are now in France, have been invited to head the research group.

Organized in three general sections, a symposium on coal, petroleum and their derivatives has been arranged by the Scottish Sections of the Royal Institute of Chemistry. It will be held in Scotland, July 7-12, at the University of St. Andrews.

Tung oil exports from China in 1947 are estimated at 30,000 metric tons. The estimate is based on information to the American Embassy at Nanking from the Chinese Ministry of Economic Affairs. Probable exports of hog bristles are given at 4,902 metric tons, peanut oil, 7,500 metric tons, and soybeans 500,000 metric tons.

Production of liquid chlorine has begun at Hacienda Paramonga, Peru, and is expected to reach approximately 800 metric tons annually. Domestic requirements are estimated at 100 tons.

THE CORROSION FORUM

MODERN MATERIALS • MODERN METALS

of Chemical & Metallurgical Engineering

Edmond C. Fetter, ASSISTANT EDITOR

Acetic Acid and Chlorine vs. Materials of Chemical Plant Construction

Stainless steel, protective coatings, and Haveg are here added to the list of materials whose corrosion resistance was discussed in two recent symposiums. The first symposium considered the resistance of various materials to acetic acid and was published in this column in the November and December issues of 1946. The second symposium, on chlorine, appeared in January, February and March of this year.

HAVEG

E. P. MAMPE
Haveg Corporation
Newark, Del.

HAVEG, a plastic construction material, is well known in the chemical industry for its resistance to corrosive conditions. Although available in several different grades, the two most widely used are Haveg-41 and Haveg-60, both of which contain a special acid-washed fibrous asbestos filler. The plastic component in Haveg-41 is a heat-hardened phenol-formaldehyde resin; in Haveg-60 a furfuryl alcohol resin is employed.

Haveg-41, the older and more widely known grade, has been used with complete success under all conditions of temperature and acetic acid concentration with the possible exception of boiling glacial acid. Occasionally under these extreme conditions the phenolic resin may swell and in the case of pipe may result in cracks due to differential expansion between the inside and outside of the pipe wall. These cracks, when they do occur, may not go completely through the wall, but show up merely on the outside surface with no resultant leaking. It should be emphasized however that even with boiling glacial acetic acid there is no chemical degredation of the resin. Haveg-41 has been extensively used in the storage and handling of acetic acid in the food industry in the manufacture and use of vinegar, and in the textile field for agers used in the acid fixing of dyes in printed cotton goods.

Haveg-60 provides the same excellent resistance as does Haveg-41 and is totally unaffected by even boiling glacial acetic acid. Those few applications which resulted in swelling of Haveg-41 had no affect on replacement equipment fabricated from Haveg-60.

The following table shows laboratory results on both these grades using unaerated 30 percent and glacial acetic acid under varying temperature conditions, the samples being submerged in the liquids for a period of 180 days or longer.

Conc. and Temp. Of Acetic Acid	Resistance Rating Haveg-41	Haveg-60
30 percent, 50 deg. C.	Excellent	Excellent
100 deg. C.	Excellent	Excellent
Glacial, 25 deg. C.	Excellent	Excellent
50 deg. C.	Excellent	Excellent
100 deg. C.	Good	Excellent

These laboratory findings are based on an intensive study of weight and volume changes in the test specimens, as well as physical and chemical changes in both specimens and liquids, and have been confirmed by field experience over the past decade.

STAINLESS STEEL

Research Department
Allegheny Ludlum Steel Corp.
Pittsburgh, Pa.

STAINLESS steels are widely used in acetic acid and acetic anhydride applications. These include stills, columns, bubble caps and trays, pipe lines, and storage tanks required in the manufacture of acetic acid; tanks, spinnarets, and other equipment used in processing rayon and acetate textiles; photographic and food processing equipment, and many other services where acetic anhydride or acetic acid in various concentrations from dilute solutions to the concentrated acid are involved.

While all of the stainless steel grades resist attack by acetic acid, Types 304 (0.08 max. C, 18-20 Cr, 8-10 Ni), 308 (0.08 max C, 19-21 Cr, 10-12 Ni), 316 (0.10 max. C, 16-18 Cr, 10-14 Ni, 2-3 Mo), and 317 (0.10 max. C, 18-20 Cr, 10-14 Ni, 3-4 Mo) have been most extensively used in equipment for the manufacture of acetic acid. These four types furnish practically equal corrosion resistance to acetic acid solutions of all concentrations at temperatures up to the boiling point. Types 304 and 308 are usually chosen for contact with 100 percent acetic acid vapors, the liquid acid, or its solutions. Types 316 and 317, which offer a greater measure of protection against corrosion by pitting, are best suited for handling dilute vapors, or at high temperatures and at pressures above normal atmospheric pressure. Aeration or agitation do not increase the corrosive effect of acetic acid on stainless steels.

Types 304 and 308 are commonly

To date, five articles or symposiums have appeared in this series and are now available individually as reprints. Each considers the fitness of typical construction materials for service with a particular chemical. Chemicals covered and reprint prices are listed below. Address Corrosion Forum Dept., *Chemical Engineering*, 330 W. 42d St., New York, 18, N. Y.

Phosphoric Acid	25c.
Sulphur	10c.
Acetic Acid	25c.
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. . . right over my steel wire before I'm woven, to take on separating, sorting and cleaning jobs with flour, chemicals, powders, seeds and foods.
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Want to form me? Go ahead! Easy? You bet- unroll me and I'm always flat and straight- don't draw like other cloths.
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Woven in a large range of square meshes; available in rolls or cut pieces; made into reel covers; furnished with hook strips or webbing.
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BUFFALO 2, N. Y.

used for most operations involving acetic acid in the manufacture and processing of rayon and acetate textiles. Type 316 is frequently selected for service at high temperatures.

The food processing industry has found equipment constructed of Type 304 to be highly satisfactory for almost every process involving acetic acid or vinegar, except some in which the presence of sodium chloride causes corrosive attack by pitting. This pitting effect is often completely resisted by Type 316, which can be used for certain kinds of brines and preserving solutions containing acetic acid, sugar, and salt.

Type 316 is the best of the stainless steel grades for photographic processing, engraving, and lithography. Tanks and trays of this material are excellent for developing, fixing, and stopping solutions used in connection with both color and black-and-white photography.

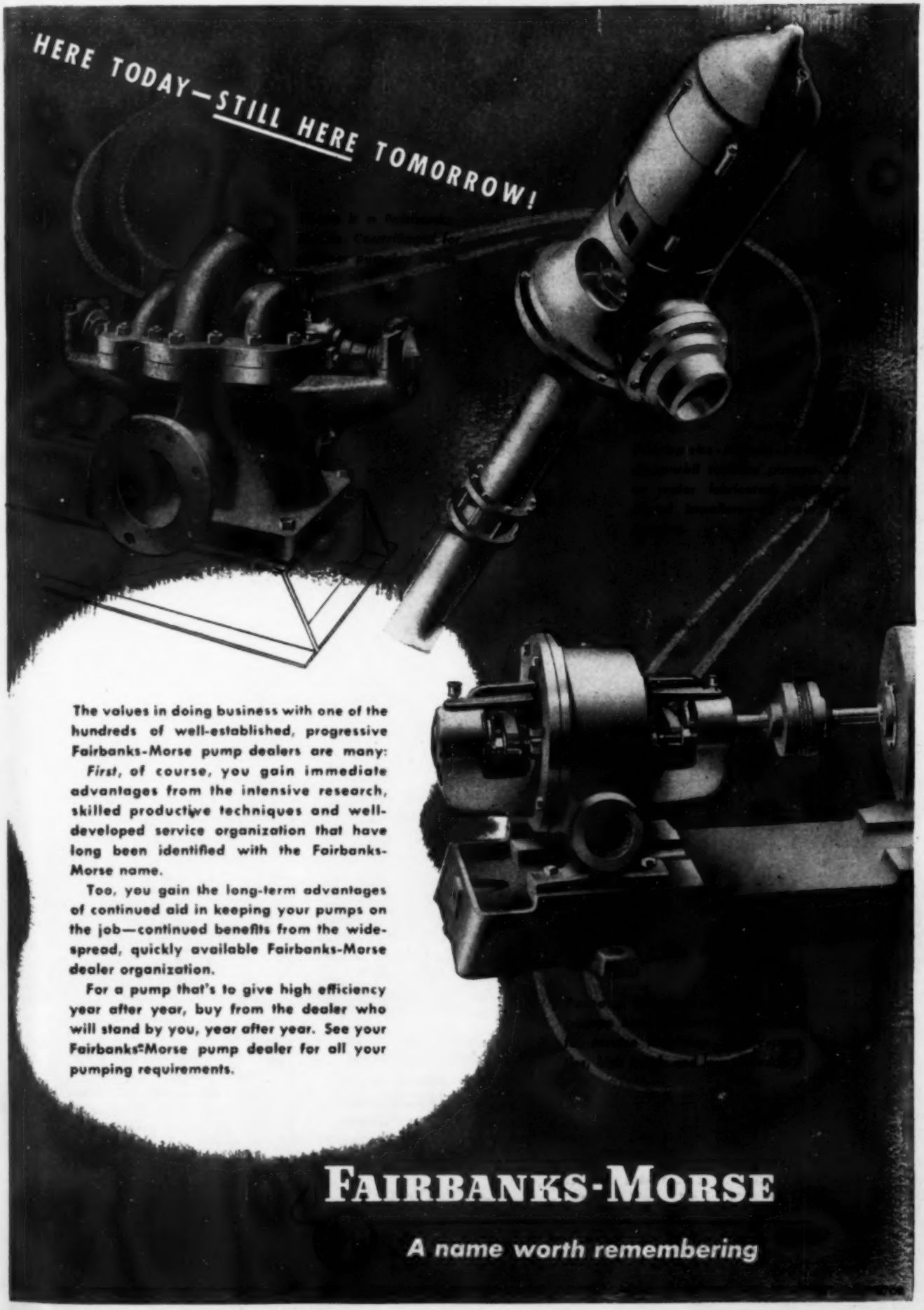
The suitability of stainless steel for virtually unlimited service in contact with acetic acid has been proved by entirely satisfactory performance under actual operating conditions.

PROTECTIVE COATINGS*

THERE does not appear to be much available information on the action of acetic acid on protective coatings. Quite a few of the synthetic resins and plastics have satisfactory resistance to acetic acid by themselves. Some of these when they are put on in the form of protective coatings do not have resistance on the same order as the plastic itself. With all protective coatings, the resistance of the coating depends considerably on the way in which it is applied, as well as the composition of the coating. It cannot be overemphasized that for any protective coating to stand up well in contact with acids or acid gases the metal must be well prepared and the coating properly applied. Many of the manufacturers of proprietary protective coatings claim resistance to acetic acid. Very few of them are definite about what concentrations and at what temperatures they have given adequate service for a reasonable length of time. Some of the plastics, such as polyvinyl chloride, the conjoint polymer of vinyl chloride and vinyl acetate, phenol formaldehyde resins, styrene resins, the polyvinylidene resins, rubber, neoprene, Thickol, etc., are resistant to acetic acid in various concentrations. Of the proprietary coatings for which information has been received, the following statements may be made:

Heresite, a baked phenol formalde-

* The author of this article is with a large chemical company which uses, but does not produce, protective coatings.



The values in doing business with one of the hundreds of well-established, progressive Fairbanks-Morse pump dealers are many:

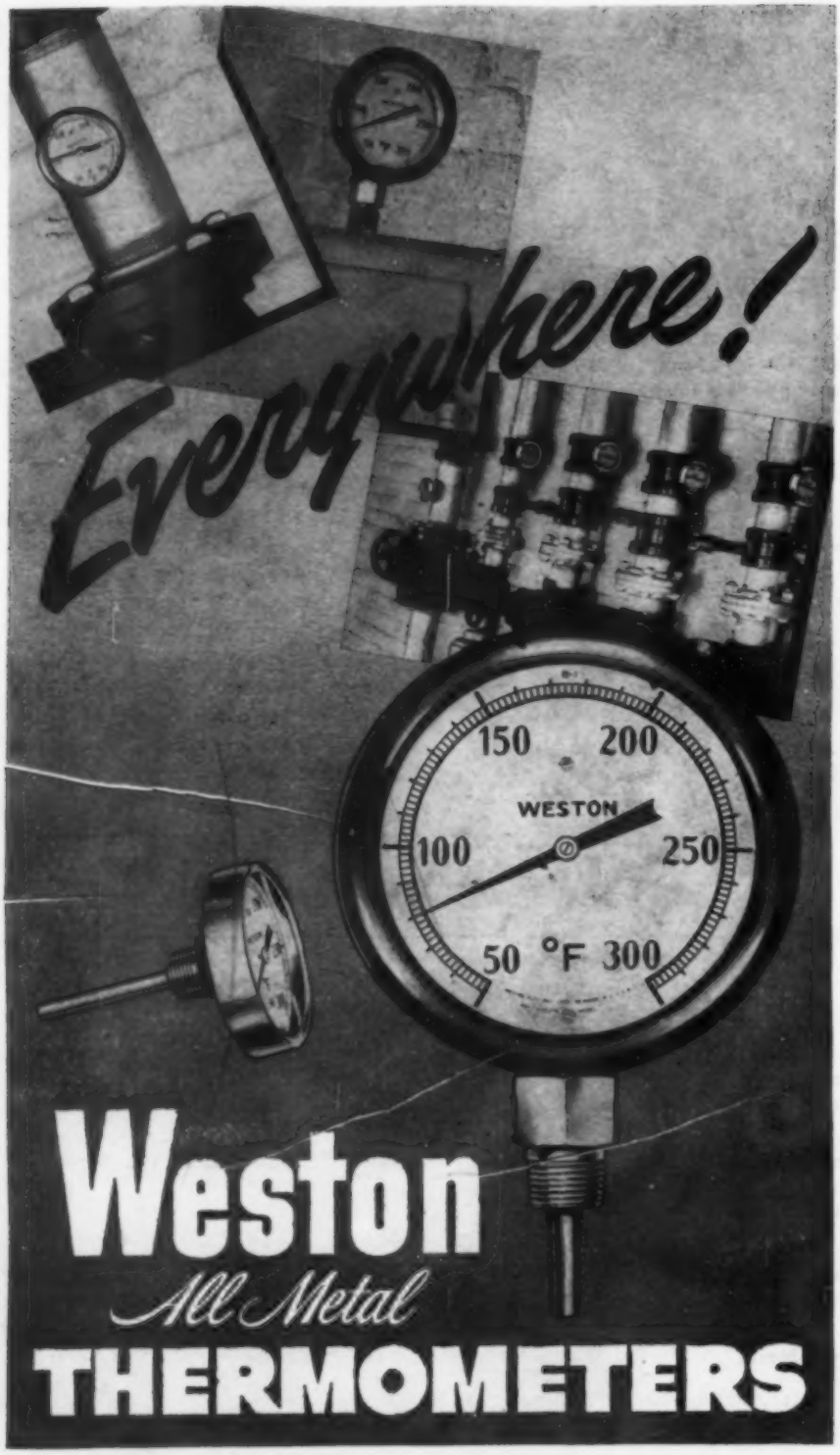
First, of course, you gain immediate advantages from the intensive research, skilled productive techniques and well-developed service organization that have long been identified with the Fairbanks-Morse name.

Too, you gain the long-term advantages of continued aid in keeping your pumps on the job—continued benefits from the widespread, quickly available Fairbanks-Morse dealer organization.

For a pump that's to give high efficiency year after year, buy from the dealer who will stand by you, year after year. See your Fairbanks-Morse pump dealer for all your pumping requirements.

FAIRBANKS-MORSE

A name worth remembering



On equipment, on pipe lines, on bearings . . . wherever temperatures are critical, the WESTON Thermometer is now widely used because of its *readability*, its all-metal *ruggedness*, and its proved, long-time *dependability*. Available for general requirements, including a Max-Min Model which indicates high or low temperature reached since last setting. If your jobber cannot supply you, ask your local WESTON representative, or write . . . Weston Electrical Instrument Corporation, 590 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

hyde resin was reported satisfactory for all concentrations up to 175 deg. F. Heresite AD 640, a vinyl resin, air-dry, good up to 3 percent concentration at 100 deg. F. Quigley Triple A Black and Heavy Duty Black, good up to 20 percent, not recommended above 20 percent. Amercoat Nos. 16, 23, and 31, 2 percent maximum. Amercoat 44, 5 percent maximum. Fedelco plastic coating exposed in 5 percent acid at 70 deg. F. for six months, still in good condition; exposed in 15 percent at 70 deg. F. for six months, in poor condition. Prufcoat, Tygon, Corrosite and Neolac claim generally good resistance to acetic acid as air-dry coatings. Tube-Kote, Inc., claim that their TK-2, a thermosetting plastic coating, is resistant to glacial acetic acid at 160 deg. F.

HAVEG

D. R. GAYLE
Haveg Corporation
Newark, Del.

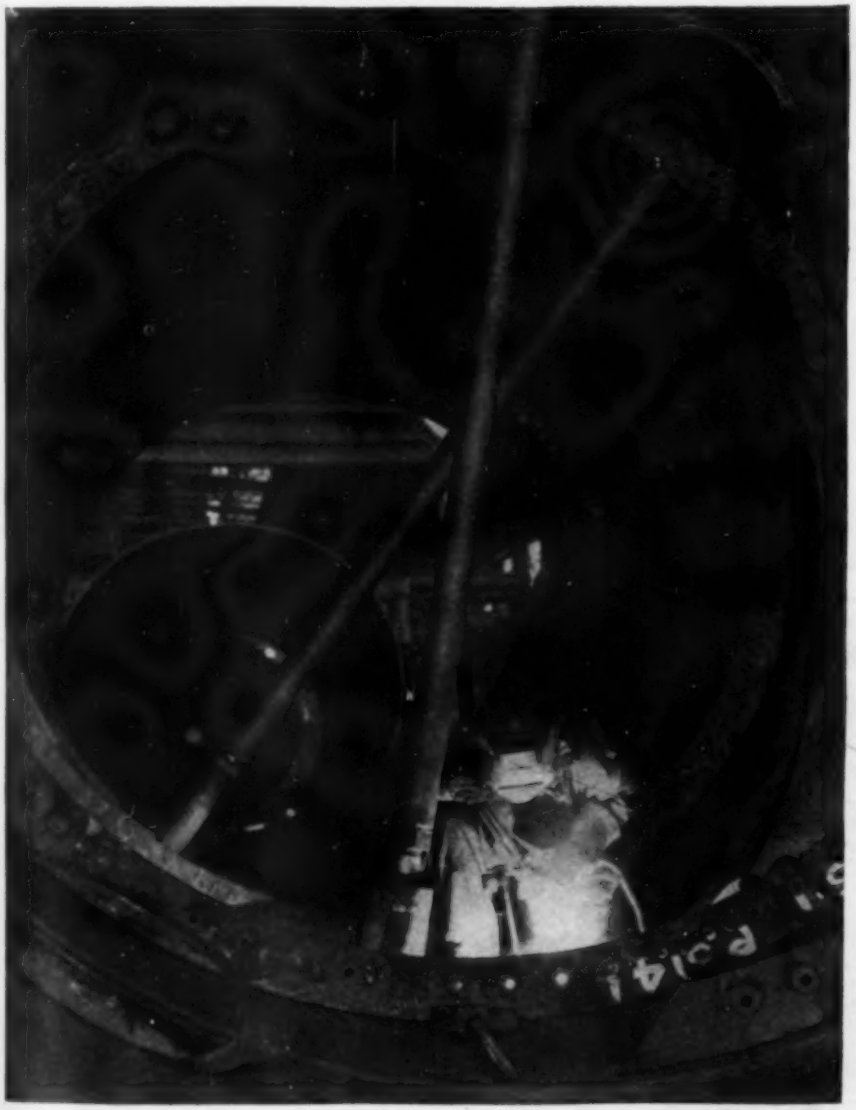
HAVEG is a molded plastic that is readily adaptable to almost any type of process equipment needed to handle wet or dry chlorine gas. It is a construction material, not a lining or coating, and has the same resistance to corrosion throughout. It can be molded at nominal cost into duct, pipe, jets, and large chlorine coolers including solid molded tube sheets and shells up to ten ft. dia. For chlorine water service, pumps of Haveg have given excellent service.

From a corrosion standpoint, Haveg is recommended for chlorine, wet or dry, as well as for chlorine water. Haveg in the form of duct work and cell headers has been in continuous service for 15 years without attack. For normal chlorine service, either pure or with traces of hydrochloric acid or other inorganic impurities, Haveg-41 or Haveg-60 give excellent service. Where chlorine is to be used in the presence of organic solvents such as benzene, ethylene dichloride, alcohols or chloracetic acid Haveg-60 is recommended. Over a wide range of chlorine handling, both in production and reaction with other chemicals, Haveg will give an installation that is entirely permanent.

From a mechanical point of view, Haveg is tough, completely resistant to thermal shock, and will stand considerable abuse in handling and erection. It can be cut or machined in the field so that outlets, additions, alterations, or repairs may be made in service. In some field construction work Haveg is supplied as a cold setting cement which requires only the addition of a small amount of catalyst to harden the compound. This catalyticly hardened material sets readily and has the same

FOR LOWEST COST CONTROL OF HIGH TEMPERATURE CORROSION IN REFINERY PRESSURE VESSELS

—nothing equals Stainless Steel!



REFINERY experience with many kinds of pressure vessel linings has clearly demonstrated this fact: —From the standpoints of economy, durability and prolonged corrosion resistance none can be compared with Stainless Steel liners applied by welding.

In more than 500 applications, Stainless Steel bubble tower linings have shown an apparently unlimited life in hot end service. Many of them lined in the shop and in the field, ten and more years ago, are still in successful operation. Even when handling sour crudes at 900°F. and higher, U·S·S Stainless Steel linings reduce corrosion to a minimum.

Just how economical such linings are—despite Stainless Steel's higher first cost—is indicated by the experience of a leading oil company. Before setting up a program for standardizing on stainless steel for pressure vessel lining, they made a careful study to determine comparative costs on the basis of life expectancy. Here is what they found by actually lining bubble towers:

- *Arc-welded carbon steel lining* (0.75 in. in heading, 0.5 in. in shell lining) cost $12.62 per sq. ft. Life was estimated at 4.5 years, making cost of lining $2.81 per sq. ft. per year.
- *Sprayed cement coating* cost $3.11 per sq. ft. Life was estimated at 1¼ years—making cost of lining $2.49 per sq. ft. per year.
- *Welded Stainless Steel lining* (0.109 in. thick) cost $4.95 per sq. ft. With life conservatively estimated at 15 years, lining costs $0.33 per sq. ft. per year!
- In other words, savings with Stainless Steel linings as compared with carbon steel linings were given as $2.48 per sq. ft. per year, or 88.3%;—as compared with sprayed coating, $2.16 per sq. ft. per year, or 86.7%.

U·S·S STAINLESS STEEL

USS STAINLESS STEEL — UNITED STATES STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
UNITED STATES STEEL SUPPLY COMPANY, *Chicago, Warehouse Distributors*
United States Steel Export Company, New York
7-886

The various grades of U·S·S Stainless Steel available for lining use and a complete description of the most approved methods of field lining are fully detailed in our booklet "U·S·S Stainless and Heat Resisting Steels for the Petroleum Industry." We will be glad to send you a copy and believe you will find it helpful.

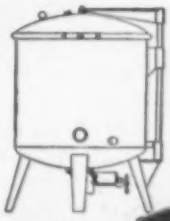
UNITED STATES STEEL

POSITIVE FILTRATION

FOR AIR, GASES, OILS AND OTHER FLUIDS

There is a Skinner Purifier, either standard or built to specific requirements, for every filtration job. Skinner Purifiers remove contaminants by microscopic filtration . . . simple in operation . . . dependable in action . . . easily cleaned.

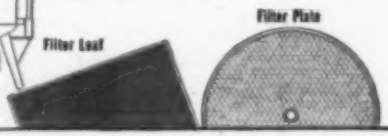
Air • Apple Products
Animal Oils and Greases
Beverages • Brines
Chemicals
Corn Products
Diesel Fuels
Drugs • Dyes • Edible Oils
Electroplating
Engine Oils
Fermented Beverages
Food Products
Fuel Oil and Water
Gasoline and Water
Glues and Adhesives
Hydraulic Oils
Inert Gases
Kerosene and Water
Liquid Soaps
Lubricating Oils
Oily Condensates
Petroleum Oils
Pharmaceuticals
Plating Solutions
Plastics • Sugars
Syrups • Textile Solutions
Varnishes and Resins
Vegetable Oils • Wines
Water • Yeast



Pressure Filter

SKINNER LEAF AND PLATE TYPE FILTERS

These filters operate with or without filter aids. Maximum efficiency and economy is assured. New and advanced designs in a full range of sizes. Fast opening. Faster cleaning.

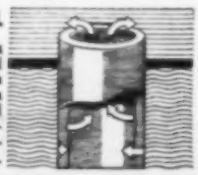


Filter Leaf

Filter Plate

PROTECTIVE FILTERS FOR GAS AND OIL

Tubular filter elements for fine filtration of hydraulic, lubricating and fuel oils and other liquids; air, acetylene, hydrogen and other gases. Ideal for the protection of instruments, air-actuated systems and internal combustion engines. Properly designed for back-washing and back-blowing for easy cleaning and economy.



SKINNER PURIFIERS INC. 1500 Trombly Avenue Detroit 11, Michigan

SEE ERTEL BOOTH AT PACKAGING SHOW

The New "ESA" MULTIPLE SPOUT VACUUM BOTTLE FILLER

EASILY ADJUSTED NO DRIP SPOUTS

ALLOWS OPERATOR USE OF BOTH HANDS

TOTALLY ENCLOSED MOTOR UNITS

Here's the answer to your bottle filling requirements. The Ertel ESA, in the low price field, will fill bottles accurately and economically. Write for full information on this quality-engineered Ertel unit.

ERTEL ENGINEERING CORPORATION
KINGSTON NEW YORK

New York City Sales Office: 40 West 48th Street, New York 19, N. Y.

ASBESTOS FILTER SHEETS • ASBESTOS SHEET FILTERS
BOTTLE FILLERS • PORTABLE MIXERS • PLASTIC PUMPS

corrosion resistance as Haveg. This cement may also be used to fabricate molded fittings in the field or may be used to make connections to brick work between bricks and fittings.

Chlorine duct is made in ten foot lengths up to 42 in. diameter with pipe to stand moderate pressure made up to 12 in. dia. The ease of handling and working of Haveg results in considerable saving in erection and support costs.

Although Haveg-60 will stand caustic and chlorine separately, it is not suitable for drying chlorine where sodium hypochlorite is present, although it does quite well for calcium or magnesium hypochlorite. Haveg also is not recommended for chlorine drying using sulphuric acid above 50 percent.

STAINLESS STEEL

Research Department
Allegheny Ludlum Steel Corp.
Pittsburgh, Pa.

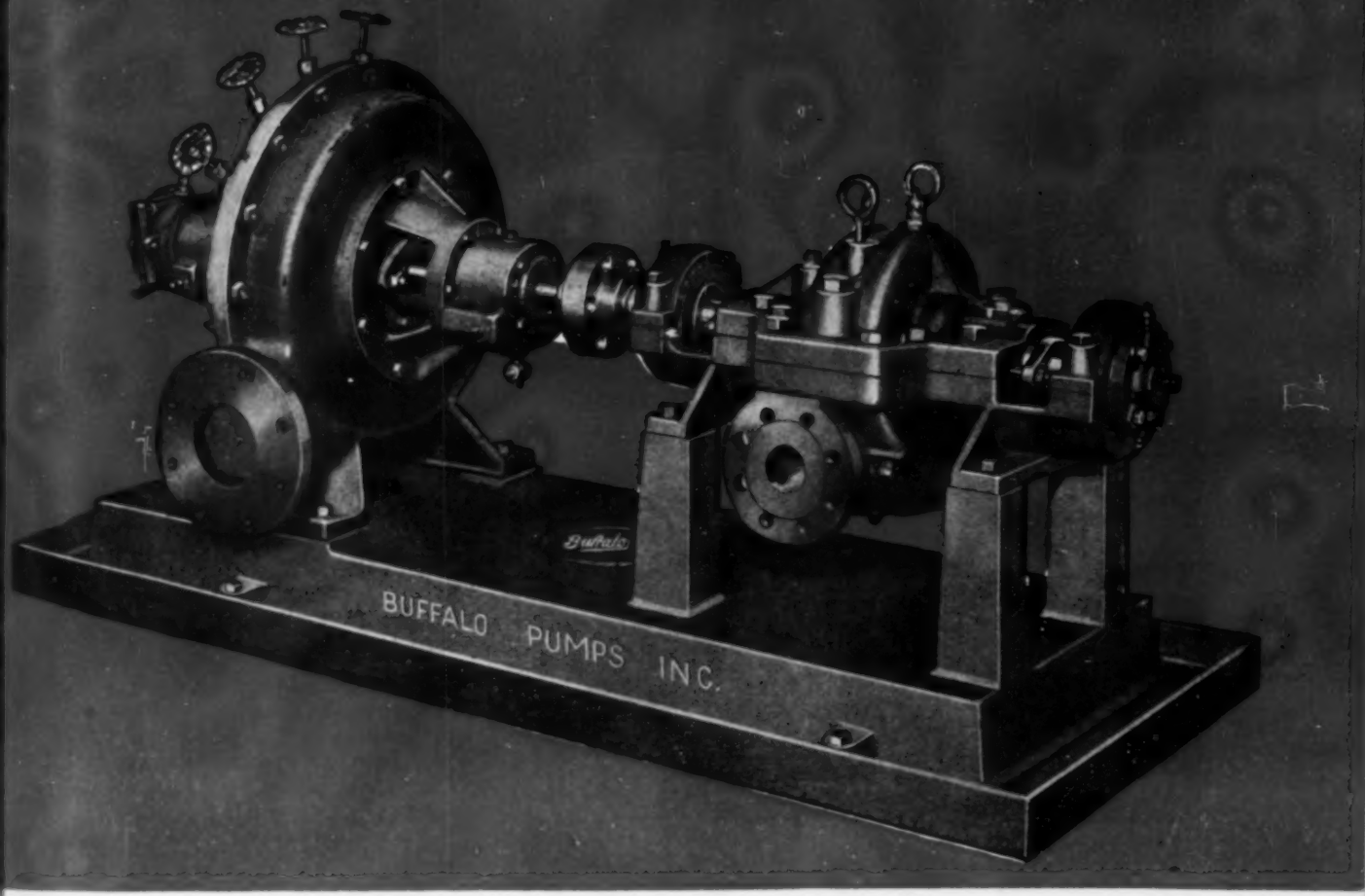
ALTHOUGH chlorine is one of the most corrosive substances known, stainless steel offers useful resistance to attack in applications including tubing for carrying dry chlorine gas, tanks, pipelines, screens, and pump parts for handling certain bleaching solutions and rinse waters in pulp and textile bleaching processes, sterilizing equipment, and other services where the operating conditions are properly controlled.

Types 304, 316 and 317 are suitable for exposure to dry chlorine gas and to mixtures of dry air and chlorine gas at low temperatures. If moisture is present, rapid attack will occur at all temperatures due to the formation and condensation of hydrochloric acid. Severe attack can be expected when the dry gas is used in the vicinity of 800 or 900 deg. F.

Most of the industrial pulp and textile bleaching applications involve solutions of unstable chlorine compounds such as the hypochlorites which decompose readily to form free chlorine and chlorides. Type 304 offers excellent resistance to corrosion in calcium hypochlorite solutions containing up to 3 percent available chlorine for periods of exposure not exceeding four hours. The metal must be rinsed thoroughly with water immediately after use. Types 316 and 317, which are more resistant than Type 304 to attack by pitting, are the best grades for exposure to solutions of this kind. They have been used successfully for handling alkaline sodium hypochlorite solutions containing 0.3 percent available chlorine in equipment for entire bleaching cycles.

Screens made of Type 317 are

To handle clear liquids at high pressures—



In the countless and all-important industrial pumping jobs requiring the handling of clear liquids—any temperatures—up to 1500' head—from 20 to 900 g.p.m.—you will find "Buffalo" Class "RR" Pumps the long-term, efficient answer. Reports from users show efficiencies of 75% and higher, and "endurance records" of years of service with no attention other than lubrication!

"Buffalo" Class "RR" Pumps are built with extra large bearings, extra deep stuffing boxes to hold more packing—extra sturdy rotors and shafts. Their perfect hydraulic balance and alignment insures quiet, vibrationless performance.

We invite you to look over the sectional views, elevations and specifications on Buffalo "RR" two- and four-stage pumps in *Bulletin 980-B*. Send for it, and see why these "Buffalo" Pumps deliver *longer* and deliver *more!*

BUFFALO PUMPS, INC.

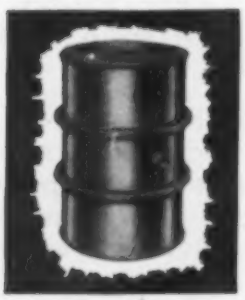
501 BROADWAY BUFFALO, N. Y.

Canada Pumps Ltd., Kitchener, Ont.

"Buffalo"

CLASS "RR" MULTISTAGE PUMPS

Don't take chances with product contamination. Use barrels and drums of Enduro—the lustrous metal that is inert to most chemical and food products—that is sanitary and easy to clean—that is resistant to corrosion—that is tough and strong—that is economical to use because it lasts so long.



The STEVENS Line offers a type and size for every chemical and food plant need. Write us for literature.

* * *

The solid head drum at the left and the patented Ringlox drum shown above are but two of the many styles in the complete STEVENS Line.

NILES STEEL PRODUCTS DIVISION
REPUBLIC STEEL CORPORATION
NILES, OHIO

STEVENS
REPUBLIC STEEL
METAL BARRELS AND DRUMS

widely used for rinsing chlorine bleached pulp and textiles where batches are frequently changed and the introduction of fresh water keeps the concentration of the chlorine relatively low.

Stainless steel can be safely treated with most commercial cleaning, detergent, and sterilizing compounds, containing chlorine, and Type 304 equipment for sterilizing bottles and restaurant ware with solutions of chlorine compounds has given highly satisfactory service.

Hospital trays made of Types 304 and 316 are suitable for handling Dakin's Solution for short periods of time. Thorough rinsing is required immediately after use.

PROTECTIVE COATINGS*

RESISTANCE of most organic materials to chlorine, wet or dry, is usually rather poor. The baked phenol formaldehyde resins are not recommended. The vinyl resins have been used to some extent up to 100 deg. F. Amercoat No. 33 has been used in the manufacture of calcium and sodium hypochlorite solutions. Prufcoat has been used as the protective coating over concrete in sodium hypochlorite solutions. For low residual amounts of chlorine in potable water, Prufcoat has been successfully used on some occasions.

* The author of this article is with a large chemical company which uses, but does not produce, protective coatings.

ADD LEAD

H. M. CHURCH, JR.
Lead Industries Association
New York, N. Y.

IN OUR original article for the symposium on chlorine (*Chem. Eng.*, January 1947, page 211) the statement was made that lead is subject to rather rapid corrosion if exposed first to relatively strong chloride solution and then to the air. This is incorrect. The error dates back to a garbled 1912 abstract. While the reference is not directly pertinent to the subject, we feel an explanation is nevertheless in order.

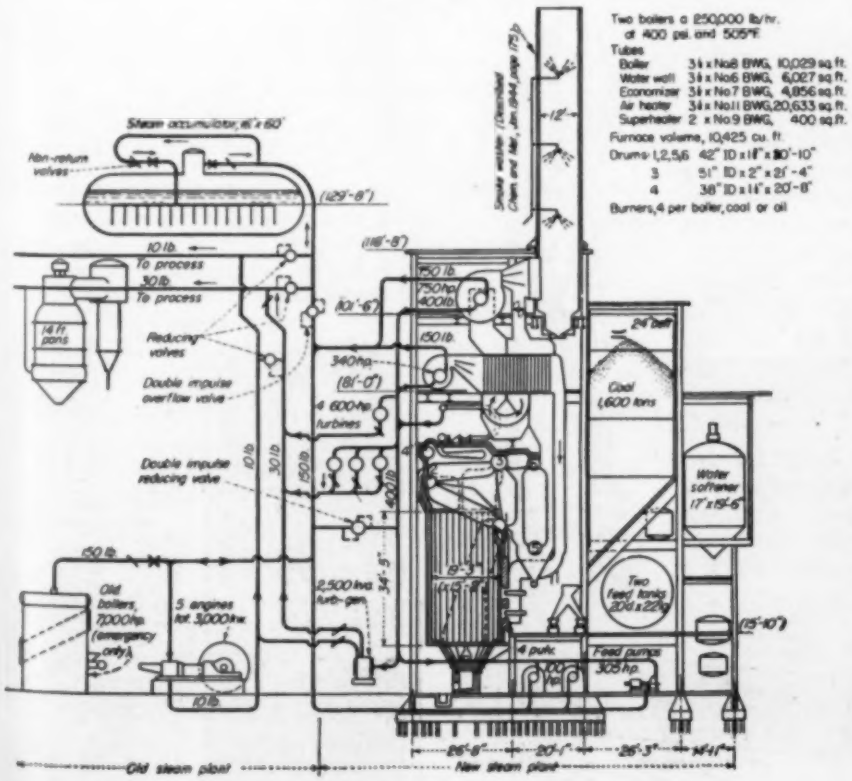
It occasionally happens that lead objects in museums suffer in appearance from corrosion, with the formation of a white lead coating. C. Matigon in 1912 concluded that such corrosion might be attributed to sodium chloride in the air as a contributing factor. We believe other contributing factors to be: water vapor in the air, traces of organic acid vapors of the acetic acid type, oxygen and carbon dioxide

FROM THE LOG OF EXPERIENCE

Dan Gutleben, ENGINEER

AN EXPLOIT of extraordinary merit for every embryo engineer is to attach himself to a college extension course in the way of an engineering journal. The absorption of information, at first discipline, becomes a fascination. Advancing years accumulate immeasurable value. The technological acquisitions supplement experience and develop confidence. By application of the same plan, the plant engineer's office of the Pennsylvania Refinery had for years been supplied with engineering and craft journals, all of which received more than casual perusal. When the need for a new steam plant was anticipated, attention was centered on pertinent material and two years later actual design started with a backlog of information supported by a scrapbook of large proportions that approached the value of a log of experience. We then understood our need and we knew how to get it.

According to a long established habit in the sugar industry, the plant engineer is charged with the design and the construction of the tools with which he has to work and he is permitted to enjoy the exhileration of achievement. The plans for the new steam plant called for two boilers at 250,000 lb. of steam per hour, each at 400 lb. working pressure and 50 deg. superheat. These replaced 13 old ones aggregating 7,000 hp. at 150 lb. pressure. The horizontal firing aisle of the old arrangement was in effect made vertical. A steam-producing tower 118 ft. high was erected on a floor space formerly occupied by four of the old boilers. As the outline shows, the 150-lb. steam system for power and process remains unchanged with its connection to five of the old boilers that were retained for use during the annual overhaul or for emergency. The 150-lb. steam is now supplied by exhaust from the turbines that drive the feed pumps, pulverizers and draft fans, supplemented by a 400-150 lb. reducing valve. The 400-lb. steam generates additional power through a turbine generator and four mechancial drive turbines for the centrifugals, and these return exhaust steam at 40 lb. and 10 lb. for the process.


Two boilers a 250,000 lb/hr. at 400 psi. and 505°F.
Tubes
Boiler 3½ x No8 BWG, 10,029 sq.ft.
Water wall 3½ x No6 BWG, 6,027 sq.ft.
Economizer 3½ x No7 BWG, 4,856 sq.ft.
Air heater 3½ x No11 BWG, 20,633 sq.ft.
Superheater 2 x No9 BWG, 400 sq.ft.
Furnace volume, 10,425 cu. ft.
Drums 1,2,5,6 42" ID x 18' x 30'-10"
3 51" ID x 2" x 21'-4"
4 38" ID x 14' x 20'-8"
Burners, 4 per boiler, coal or oil
Steam accumulator, 45' x 60'
Non-return valves
10 lb. To process
30 lb. To process
14 ft. pans
Reducing valves
Double impulse overflow valve
Double impulse reducing valve
340 hp. (81'-0")
4 600 hp. turbines
2,500 kva. turb.-gen.
Old boilers, 7,000 hp. (emergency only)
5 engines tot. 3,000 kw.
Coal 1,600 tons
Water softener 17' x 15'-6"
Two feed tanks 20' x 22'-6"
4 pulv.
Feed pumps 305 hp.
Old steam plant
New steam plant

LET ANY progressive refiner look into his past and he will see that his steam consumption per ton of product has been falling while his power demand has risen, in spite of economies here and there. He uses less steam because technique and equipment have improved and he uses more power because mechanical automatons have replaced a multiplicity of small ill-adapted though efficient, peregrinating human power plants with the big overhead. With less thinking and more money the same benefits can of course be attained by enlarging the works if the market can stand it.

The old 150-lb. steam plant used to deliver 45 lb. of steam to the power plant for which there was delivered to the process one kwh. of energy plus 40 lb. of exhaust steam at 10 lb. pressure. The modern high pressure industrial plant using steam at a pressure of 400 to 600 lb. delivers one kwh. of energy for 25 lb. of steam and returns 21 lb. of exhaust at a pressure of 40 lb. The mechanical drive turbines require 100 lb. of steam at 400 lb. pressure per kwh. and exhaust at 150 lb. pressure into the old power plant and by this compounding return 1 kwh. for 32 lb. of 400-lb. steam plus 30 lb. of 10-lb. exhaust. The public service power plant has no use for exhaust steam and accordingly condenses it with cold water. It consumes about 10 lb. of high pressure steam per kwh. and wastes more than half of the heat of the steam by way of the condenser water to the sewer.

IN THE OLD SUGAR HOUSE the 10-lb. exhaust steam is used in the quintuple effect evaporator and vapor is drawn from various effects for heating sugar liquors. At the same time additional exhaust or live steam is used for further heating and for the vacuum pans. The modern quintuple effect takes steam at a pressure of 40 lb. or higher and after it has evaporated a pound of water or more per pound of steam its pressure is still high enough

Trentweld

for everything you want in

STAINLESS TUBING

for
Corrosive applications
•
High pressure service
•
High temperature installations

Any size from 1/8" to 30" diameters in lengths up to 24 feet

Finished to any degree exterior or interior

Precision production held to micrometer tolerances

TRENTWELD advantages are all inclusive, important to every user of austenitic stainless steel tubing. They are based on a singular automatic method of rolling and fusion welding that produces improved characteristics in the metal—an unusual uniformity in composition and structure. This increased capacity for service is further fortified by special conditioning for chemical use in precisely controlled annealing and pickling operations. Carbon content can be held as low as 0.02–0.03%.

Call on Trentweld engineers for help in determining the best alloy among stainless steels or Inconel to meet the need of your particular problem. Without obligation, address Dept. 10 on applications you have in mind, or write for the Trentweld Data Bulletin.

TRENTWELD STAINLESS STEEL TUBES

Sales Office—664 N. Michigan Avenue
Chicago 11, Illinois

TRENT TUBE MFG. CO.

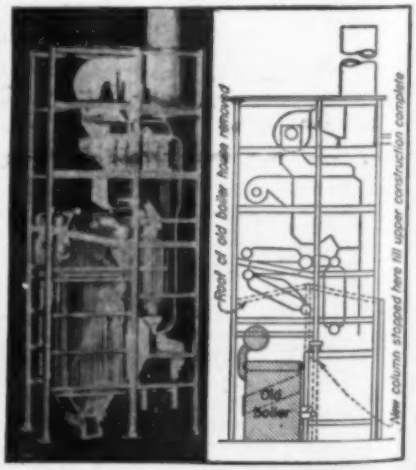
Mill at
East Troy, Wisconsin

for the pans and all of the heating. The saving appears in the reduction of vapor to the condenser.

THE "OLD MAN" was surprised when the figures showed what could be accomplished with a new steam plant. The old stokers and low furnaces could burn only low volatile coal which in the local market was the highest in cost per unit of calorific value. On the other hand smoke-infested high volatile slack was a drug on the market and accumulated in mountainous heaps during the season when the cement plants were idle. It was estimated that a modern steam plant could accomplish with 85,000 tons of gas slack screenings annually the same job which demanded 115,000 tons of high priced coal in the old boilers. The difference in the prices was a dollar a ton. The actual saving achieved the return of the capital expenditure in seven years. It could have done much better but for the fact that the government coal umpire adjusted coal prices to proportion with calorific value irrespective of other qualities. Nevertheless our high volatile still has an advantage over the low volatile of a competing plant by a cent or more per thousand pounds of steam.

THE STEAM PLANT is the heart of the works and its physical analogy as to location has the advantage of short steam lines. For the two new boilers there was no space available except by the removal of four of the old ones. Thanks to the steam accumulator (described in the Log, March, 1947) installed four years earlier, two of the old boilers could be spared so as to permit the erection of one of the new ones from the ground up. The second pair of old boilers could not be released

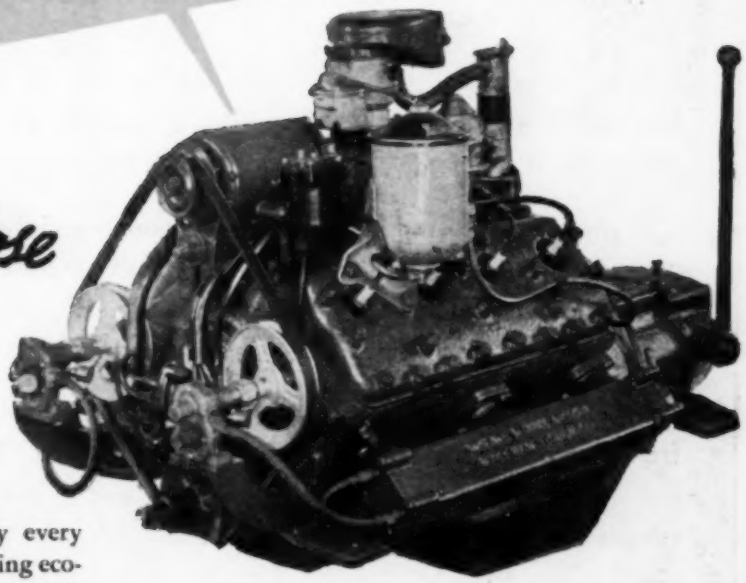
Design of the new boiler is shown by photograph of cut-away model. Sketch shows how most of new boiler was built over and around the old, permitting operation of the latter till the last minute



American Flexible Metal Hose, of fully interlocked steel, is used on this crop dusting machine manufactured by Carnes, Gummelt & Co. Dusting Machine Works, Chilton, Texas. This lightweight, uniformly flexible metal hose is easily adjustable for height and width of rows.

From Dusting Crops to Cooling Marine Motors...

American Seamless Flexible Metal Tubing is used by Mohawk Marine Motors of Garfield, New Jersey, in this converted marine motor. This tubing, in cooling system connections, assures long life, 100% tightness under pressure, and valuable protection against heat, vibration and rough service.



Flexible Metal Hose performs best

There is no beginning and no end to the range of uses for American Metal Hose products. For many unusual applications, and in practically every industry, American Flexible Metal Hose and Tubing economically convey steam, oil, water, other liquids, semi-solids or gases—usually where vibration, misalignment or connecting moving parts create a problem.

American Seamless Flexible Metal Tubing, flexible as garden hose and leakproof as the seamless bronze tube from which it is made, is standard in sizes ⅛" to 4" I.D. American Metal Hose, manufactured from strip in four spirally wound types, is available in brass, bronze, aluminum, steel and other metals, in sizes ⅛" to 12" I.D.

From these "American" products, you can obtain just the type of flexible connection that will best serve your needs. Tubing and hose can be fabricated with end fittings to your specifications.

For detailed information write for Publication SS-50. Consult our Technical Department on any exceptional problems.

ANACONDA

American

METAL HOSE

THE AMERICAN BRASS COMPANY

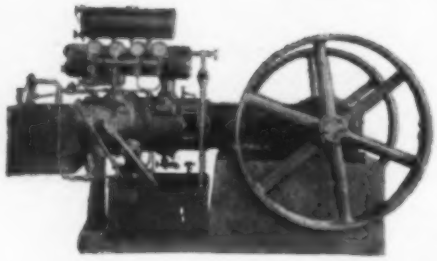
American Metal Hose Branch

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: THE CANADIAN FAIRBANKS-MORSE CO., LTD., *Montreal 3, Canada*

IT'S A NORWALK



HIGH PRESSURE COMPRESSOR

Built by the Pioneers of the Industry

Your compressor has a specific job to do. If it's a Norwalk it was especially designed and built to do that job, to do it efficiently, and to do it for a long time.

If you are interested in how Norwalk combines individual design and construction methods with modern practices of standard production of interchangeable parts, send for a copy of our catalog, just off the press.

In this new catalog each type is described and illustrated, from single stage to five and six stage compressors. These are shown in various sizes and capacities, and in pressure ranges from 300 p.s.i. to 20,000 p.s.i.

NORWALK COMPANY, INC.

10 NORTH WATER STREET, SOUTH NORWALK, CONN.

Manufacturers of High Pressure Compressors for Air and Gases for more than 80 Years

till October but erection of the new one could not be delayed.

In the cross section of the new boiler house there are three rows of columns, two in the walls and one between. Two of the new columns in the interior row were stymied by the stokers of the old boilers but this did not prevent construction above. The first tier of these columns was therefore passed over and the erection started with the second tier, the bottom of which projected a couple of feet below two straddling temporary beams resting on the girders supporting the old coal bunker. The wind bracing in the new steel supplemented this support by delivering a part of the load to the wall columns. This permitted the upper part of the building to be completed as well as the boiler, draft fans, air heater and stack. After the obstructing boilers were removed in October, the piles were driven for the two remaining piers, ther the steel columns were hung in place and finally the concrete was poured around the dangling anchor bolts under the base plate.

It was necessary to give the riggers an accurate starting level for the second tier columns. The chronicler manipulated the instrument and set the temporary support to a l.ai'. Then, guessing that there would be some deflection under the 100-ton load, added as a shim a ¾-in. steel plate which was adventitiously found in the scrap pile near at hand. After the constructors hung the columns and poured the concrete, the base was a sixteenth inch high. The Old Man concluded that this degree of accuracy had been attained by mathematical wrangling and this improved his esteem of the engineering department's skill. No effort was made to correct this impression. On the last day of operation of the old obstructing boiler, with only two tons of coal left in the bunker shown above, a tube failed—the first in ten years. By the time the last of the coal slid into the stoker, steam was oozing out of the front. The old boiler died with her boots on.

THE "CHECKER PLAYING" necessary to temporize with the various obstructions such as sand filters, pipes, conduits and conveyors and their eventual removal without interference with sugar production, required many Sundays of effort plus an expenditure of over $40,000. The iron workers threaded the new columns through holes in the roof. When the blast of the whistle called these "dynamiters" from labor to refreshment, they came down the manlift in tandem, the second passenger on a respective step mounting on the shoulders of the first.

COST CUTTERS

CHEMICAL PLANTS..

cut costs with CLARK STEAM TRAPS. Large volume air removal gives quicker heating up action—saves fuel. Elimination of condensate permits rapid, full flow of new dry, live steam—extends life of equipment.

For 38 YEARS...

fluid controls made by Clark have been saving fuel and increasing equipment efficiency wherever steam, air or gas are used.

Cost Cutters in...

- **Laundry and Dry Cleaning Establishments**
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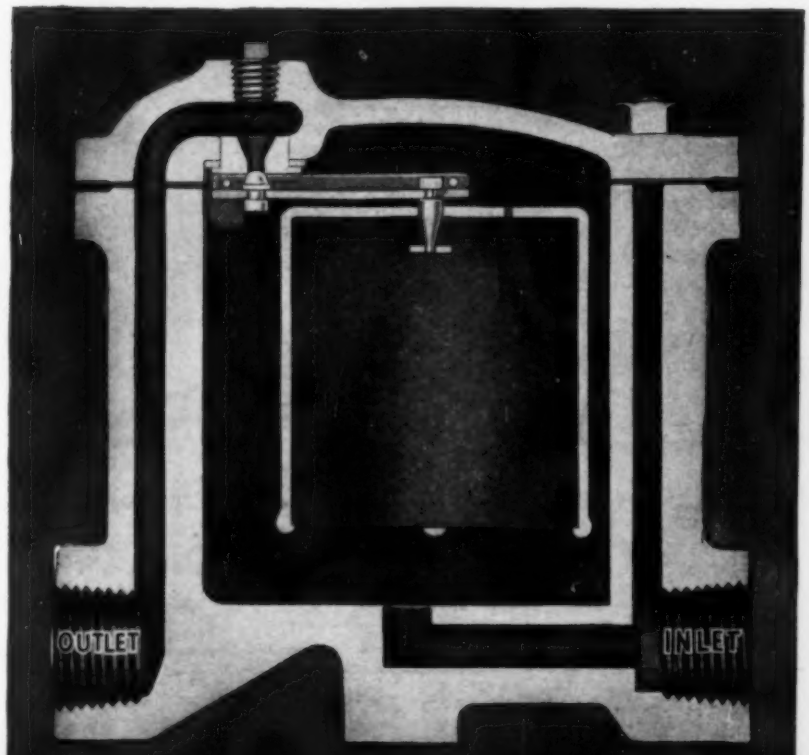
- **Chemical Plants**
- **General Industry**



The popular **CLARK SERIES 70** Inverted Bucket Type Steam Trap with Clark patented Bucket Venting Device and other exclusive Clark features. For general drainage service. Available in 3 sizes: ½", ¾" and 1". For pressures up to 200 P. S. I. and temperatures up to 400° F. Write for free catalog for complete specifications and applications of the wide line of Clark Fluid Controls.

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FLUID CONTROLS

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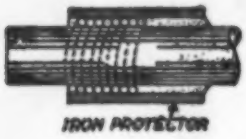
STEAM AND FLUID TRAPS	STRAINERS	PRESSURE REGULATORS
VACUUM AND LIFTING TRAPS	VALVES	REDUCING VALVES



VITREOSIL TUBES

Protect your Gas Sampling against errors

★ Unsuitable, unprotected iron tubes may nullify your gas sampling, introduce serious errors. Vitreosil (Vitreous Silica) tubes avoid all danger of contamination. They cannot rust. They are indifferent to thermal shock; chemically inert, non-porous. When properly protected, vitreosil tubes give long life. May be water-cooled.

★ The use of Vitreosil for Gas Sampling is fully covered in Vitreosil Bulletin No. 3. We will be glad to send you a copy; also to answer any specific questions you may care to ask us. Write for Bulletin 3.

VITREOUS SILICA — VITREOSIL

The THERMAL SYNDICATE, Ltd.
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PROCESSING UNIQUE EQUIPMENT

SAW TOOTH *Crushers*

Improved Type!

Rugged construction. Crushes material to finished size. Blades spaced to your specifications. Capacity from 3 to 15 tons. Roller bearing mounted shaft. Robinson Processing Equipment designed by engineers whose reputation is founded upon doing things right. Literature available. Inquiries invited.

ROBINSON MANUFACTURING CO.
Plant: Muncy, Pa.
SALES REPRESENTATIVE
MERCER-ROBINSON COMPANY, INC.
30 CHURCH ST., NEW YORK 7, N. Y.

The manlift was installed as soon as there was enough steel in place to support it.

SELECTING AND BUYING equipment always provides interesting experiences, respectfully submitted to the consideration of youthful salesmen. The forged steel drums were available from a large shop in Pennsylvania for $80,000 per boiler. On the other hand a German forge equipped with mandrels of the proper size offered them for $40,000 including duty and freight, and this price attracted the order. A local radio commentator mentioned names but not the price and he deprecated the lack of loyalty and patriotism. Also he overlooked the fact that at that very same time the United States Navy purchased from the same German shop one and one-quarter million dollars worth of forged steel boiler drums for new destroyers.

We selected a certain water softener for about $50,000 on the basis that the builders had the unique experience of having built one for a neighboring refinery and had lived through the inevitable pioneering. We invited no competition. A competitor called up in great displeasure. We "could at least have given him a chance to figure." It would cost $300 to prepare a proposal and, since we were prejudiced, there was no sense in asking others to waste any money. As a parting shot the disgruntled salesman averred that we had bought the worst machine on the market, and then he slammed down the receiver.

When the bids were opened for the feed pumps and the choice announced, two of the salesmen of seasoned experience, expressed appreciation for the opportunity and added that we had made no mistake. A third disparaged our judgment with the remark, "Well, I hope you don't have any trouble."

A turbine salesman exhibited his little black book wherein it was recorded that his firm had purchased annually a quarter million gallons of alcohol (12 days' output) from us and he implied that reciprocity would be appreciated. However, when he observed a great disadvantage in his price he accepted our selection of his competitor's offer with sportsmanship.

Stokers required more room than our crowded space could allow. Their design currently did not recommend them for high volatile coal (now changed). We wanted to be prepared to burn any kind of coal that might be offered including distress cargoes. And lastly our greatly fluctuating load pointed to pulverizers. Under a sudden load drop, the stoker might be charged with several tons of incandescent coal while in the case of a pul-

WeldELLS *have everything**

Welded piping is piping at its best. For welding at its best, use the fittings with the *plus-value* features listed here. These features are combined only in WeldELLS.

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New York Office: 50 Church Street

Philadelphia Office: Broad Street Station Bldg.

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* **WeldELLS alone combine these features:**

- **Seamless**—greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement**—provides uniform strength.
- **Permanent and complete identification markings**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

HERE'S THE NEW LINE OF Series K

ROPER ROTARY PUMPS

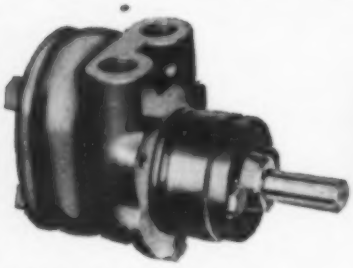

FIG. 17K PUMP HEAD with Mechanical Seal. Sizes ¾, 1½, and 3 g.p.m., as illustrated. Fig. 18K is equipped with built-in relief valve. Packed Box is available.

FIG. 1K with Packed Box. Available in 5 g.p.m. size only. Fig. 2K is equipped with built-in relief valve. Mechanical seal is available.

FIG. 1K with Packed Box — supplied in 10, 15, 20 g.p.m. sizes with companion flanges. FIG. 2K equipped with built-in relief valve. Mechanical Seal available on all models.

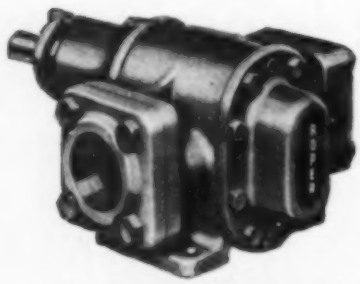

FIG. 1K with Packed Box — supplied in 30, 40, 50 g.p.m. sizes with companion flanges. FIG. 2K equipped with built-in relief valve. Mechanical Seal available on all models.

¾ TO 50 G.P.M. — PRESSURES TO 150 P.S.I.

Adaptable to a wide range of jobs . . . pressure lubrication, hydraulic service, fuel supply, or transfer work pumping clean liquids. These Ropers are self-priming, operate in either direction, handle total suction lifts up to 25 feet. Direct connected, belt, or chain driven. Because of the new Roper venturi suction and discharge principle, energy loss from cavitation, turbulence, and friction is minimized. This proportional means of distributing viscous liquids uniformly across the gear face increases operating efficiency . . . adds quietness and reduces power costs . . . permits gears to handle a wide range of viscous liquids at standard motor speeds.

Get All Of The Facts — Send For Booklet

Complete Model "K" details including specifications, exploded view of construction features, wide range of mountings, etc. Also describes other models up to 300 G.P.M., pressures up to 1000 P.S.I.

GEO. D. ROPER CORPORATION
143 Blackhawk Park Ave., Rockford, Ill.

PUMPS ESPECIALLY ENGINEERED TO FIT YOUR REQUIREMENTS

ROPER Rotary Pumps

BUILDERS OF PUMPS FOR MANUFACTURING, MARINE, PETROLEUM AND PROCESS INDUSTRIES

verizer the amount of coal in process would not exceed 500 lb. Before we acquired operating skill we had also experienced tube ruptures and in such a case the less heat stored in the furnace the better. We were willing to accept the disadvantage of increased power demand and the greater tendency to distress the neighborhood housewives on Monday mornings with fly ash. We had the solution to the fly ash problem (See *Chem. & Met.* Jan. '44). The salesman's answer to our selection of pulverizers was an intimation of defective mentality and he sent us a sheaf of newspaper excerpts recording law suits against pulverized coal plants.

High pressure valve quotations came from eight bidders and with each came a sample 4-in. valve on which we paid carrying charges both ways. We dismantled them and then arranged them in the drafting room in order of merit as judged by the eye. There was little difference in the upper two or three. However the winning valve was more attractively finished which made the impression of probity in general. The Old Man was invited to corroborate our selection. He was not in the mood to interrupt his train of thought at his desk and so he dismissed the invitation with the suggestion that we "buy the valves from George," the friend who plays customer golf. Nevertheless he succumbed to importunity and found that George's sample was at the foot of the class—and for reasons that were plainly visible. All of the salesmen were invited to view the exhibit. The winner expressed a desire to make a photograph, which unfortunately could not be permitted.

WHEN COMPLETION of the first boiler was adjudged to have been reached, the dignitaries aligned themselves in the firing aisle while the Old Man touched off the oil burner. In an hour the pressure reached 150 lb. and, with oil fuel and natural draft, production proceeded at this pressure replacing half of the old boilers. Engineer Andy from the builder's shops was satisfied. Then he raised the pressure to 400, put on a high pressure feed pump and after that proceeded upstairs to start the induced draft fan turbine, being accompanied for impressiveness by the visiting kibitzers. When he opened the throttle there followed a terrific clatter that chased everybody off the floor including Andy. In spite of the uproar, he remembered the throttle and edged back to shut it off. The big fan was churning an assortment of brickbats and debris which the constructors neglected to clean out. When tranquility returned and production was proceeding at full

ESSENTIAL *Information*

for Every User of Worm Gears

This new 48-page, data-filled catalog gives all the information necessary for the selection of correct worm and gear sets for any given requirement. It includes information concerning selection practice, worm gear rating tables, instructions for computing bearing loads, standard worm and gear dimensions and other information necessary to those requiring high grade worm gear sets for use in their own equipment. A copy of this important catalog will be mailed to you on request.

WG-4

WORM GEAR DIVISION

DE LAVAL
STEAM TURBINE COMPANY
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How TRANSITE Solves...

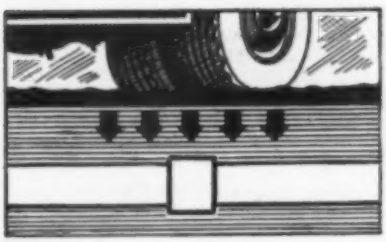
THESE 5 MAJOR WATER PIPE PROBLEMS

"RED WATER"

A Transite water line can never cause "red water" or rusty scale because Transite is made of asbestos and cement—two materials that cannot rust. This pipe protects the quality of your water supply . . . helps keep clean water *clean!*

UNDERGROUND LEAKAGE

Transite's Simplex Coupling protects against leakage because it provides a joint which is both tight *and* flexible. Thus, it absorbs the vibration of heavy traffic . . . safeguards against the stresses that are a common cause of underground leakage.

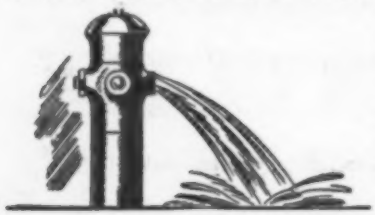


SOIL CORROSION

Tests show that most corrosive soils, often highly destructive to other types of water pipe, have little effect on Transite. In just about every type of aggressive soil—including cinder fills and salt marshes—Transite Pressure Pipe has proved its exceptional resistance to corrosion.

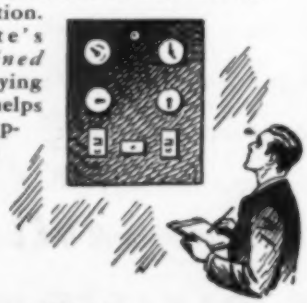
REDUCED FLOW CAPACITY

Transite provides maximum flow because this pipe has a high carrying capacity (C=140). And its capacity *stays* high because Transite is immune to tuberculation (the internal corrosion that cuts down flow rates).



HIGH PUMPING COSTS

In a Transite line, pressures never have to be "stepped up" to compensate for reductions in flow due to tuberculation. Transite's *maintained* high carrying capacity helps keep pumping costs low!



For further details about Transite Pressure Pipe for Water Supply Lines, Fire Lines and Process Lines, Johns-Manville, Box 290, New York 16, N. Y.

JM

Johns-Manville

TRANSITE PRESSURE PIPE

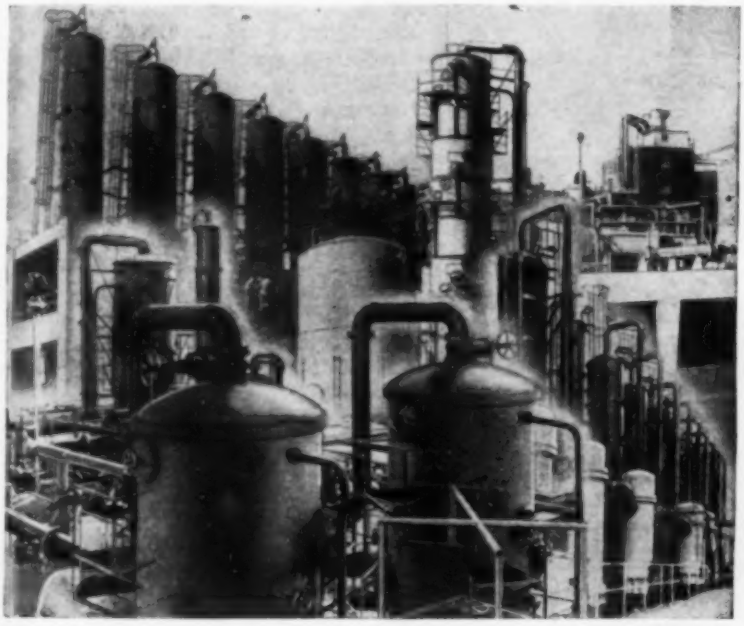
for Water Supply Lines • for Fire Lines • for Process Lines

pressure, the Old Man expressed curiosity as to the volume of the sound of a 400-lb. safety valve, and in '32 400 lb. was indeed a respectable pressure. The lead-off pipes to the roof had not been installed and so the five safety valves opened directly into the room. Nevertheless the Old Man sent Operator Billy Powers aloft to clamp down on the non-return valve. Presently there was a blood curdling blast. The constructors in the second boiler were dropping out like bees from a swarm as 5,000 hp. was converted into roar inside a closed building. The neighborhood as far as Girard Avenue "heard" that the new boiler had exploded. The performance satisfied the Old Man. He knew that the safety valves could function and he called it a successful day.

THE OLD FAITHFULS who had operated the old boilers possessed loyalty and boldness and a willingness to sit on the powder keg. It was desired to reward them by training them for the new job. Boss Tom of the old boiler house and his hewers of wood had to unlearn obsolete ideas and adapt themselves to the new techniques. This required time and in some cases was mentally impossible. One Harry, taken over from the boiler erector's crew, had operated such a boiler and was equipped with a B.S. degree. He was placed in charge of the 12-hr. night shift while Tom and his men were acquiring proficiency during the day. Occasionally Tom dropped down to the plant at low twelve to compare procedures and invariably he found the new expert reading his paper under the cool of the street light in front, leaving a footman in charge of the luxurious equipage on which we had spent nine months of heavy effort and nearly a million dollars of cash. Tom fired the expert. There is always room at the top for an expert and so ours fell into the management of a new high pressure plant in the West where his performance made the front page. Unfortunately, in partnership with an engraver and a machinist he offered competition with the United States Mint in the production of five dollar bills, and thus lost the opportunity for a promising career.

Billy Powers, having had a couple of week's experience with Tom was installed in the expert's place. Fear gripped him when he realized that he was on his own. The narrow firing aisle, devoid of natural light except a skylight a•hundred feet above, seemed like a dungeon. He was about to give up. However a few months later his feelings were reflected with the greeting, "You know, Chief, these are the

46 Years Experience



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For Creative Analysis of manufacturing requirements; higher Production Efficiency; Economical Operation; consult the Forty-Six-Year-Old Vulcan Organization specializing in Chemical Process Engineering and Equipment Fabrication.

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MORRIS
TYPE "R" SLURRY PUMP

The advanced design of this pump has all the performance requisites that engineers and operating men want. And we can prove it!

Only the Morris Type "R" Slurry Pump Has These Four Exclusive Features!

1. *The gland is under suction pressure only.* This feature practically eliminates packing troubles.

2. *The Type "R" Morris has no internal bolts or studs, no troublesome fits or joints.* To reach the impeller you remove only four bolts.

3. *You can remove the impeller without disturbing the piping.* This feature alone saves you considerable replacement and repair time.

4. *The shell is interchangeable for right or left hand rotation.* You can rotate the suction and discharge nozzles around the axis of the pump to positions in any of the four quadrants, a total of 72 combinations.

It's easy to install, dismantle, or maintain the New Morris Type "R" Slurry Pump. As a new installation or as a replacement, this pump will fit easily into your existing plant.

● The New Morris Type "R" Slurry Pump is being used successfully by many chemical and engineering plants to handle sludges and silt, the moving of all types of caustic or acid mixtures containing abrasives or solids, and mixtures containing ore concentrates, tailings, slag, and the residue from filters and classifiers.

FREE!

Send for our free Bulletin on the Morris Type "R". It shows a new kind of easily understood performance curves . . . explains how Type "R" will fit into your specific operations. WRITE FOR THIS BULLETIN TODAY.

MORRIS MACHINE WORKS
Baldwinsville, N. Y.
Sales Offices in Principal Cities

MORRIS CENTRIFUGAL PUMPS

biggest dash dash boilers in the State of Pennsylvania, and I'm running them."

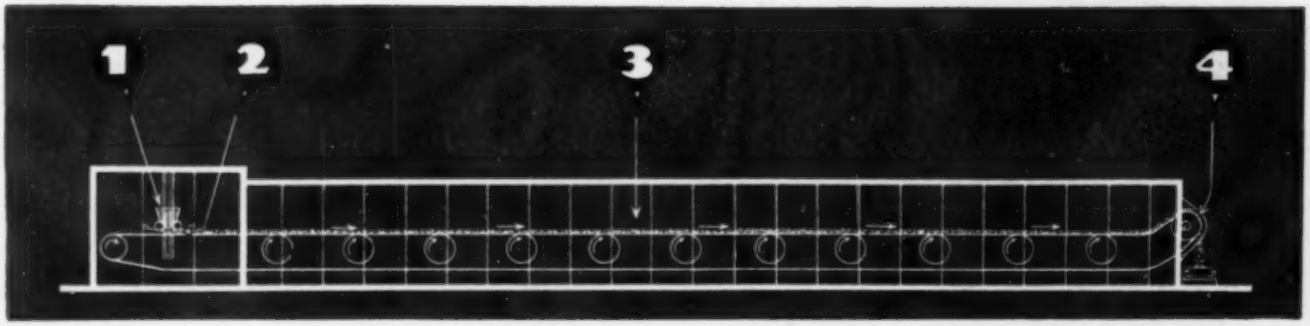
IN HIS 33 YEARS of sugar house operation the Old Man had occasionally suffered the annoyance of a tube failure but under the practice of installing a multiplicity of small units, production was not affected. However he expressed concern about the consequence of a tube failure under 400 lb. pressure. Our new boilers had to be shoe-horned into a narrow space unlimited only as to height. The maximum furnace dimensions available horizontally were 15 ft. for width and 19 ft. for depth. For the requisite volume, the vertical portion of the water walls was 35 ft. long. Only one of the boiler builders was willing to accept this limitation for the capacity required. The extra long water wall tubes entered into the lower drums of a three-drum boiler. Their length induced great speed of circulation and, at its discharge into the drums, the superheated water flashed. The steam selected certain tubes as the path of least resistance towards the steam drum above. The tubes thus selected, being starved of water, blistered and on two occasions a tube opened like a book. The Old Man was well pleased. The tube merely opened, blew out the fire, scared Billy out of a year's growth and scattered black soot through the explosion doors all over the plant. Twelve hours later a new tube was in place. This of course happened on a day when a consequential visitor was due.

THE BUYER, being suddenly relieved of narrow limits as to coal specifications, bought only on color and price. It had to be black, or nearly so, and cheap. Volatile and ash content and ash fusion temperature meant nothing to Mac. He bought a mound of waste at 10c. per ton at the mine. Once a 10-car shipment of anthracite screenings dredged out of the Susquehanna River was received and now and then there was a heavy admixture of slate. All of this stuff passed through the pulverizers and was converted into steam, albeit accompanied by a good deal of grief.

FOR COMBUSTION efficiency furnace temperatures were held as high as the fusion point of ash permitted. When a shipment of high fusion was followed without notice by another of low fusion, there was severe slagging. Sometimes the two qualities were mixed and this resulted in neither combustion economy nor freedom from slag. The low temperature encouraged carbon loss and the high temperature plugged the boiler with slag. To avoid a shutdown, when the

CLAY DRIED TO UNIFORM MOISTURE CONTENT OF 3.1% (B.D.W.B.*) AT RATE OF 2 TONS PER HOUR

*Bone Dry Weight Basis



in PROCTOR CONTINUOUS CONVEYOR SYSTEM

In one typical installation of a Proctor individually designed continuous conveyor drying system, for use in drying clay, here is what takes place. ❶ Wet clay, with a moisture content of 42.1% (B.D.W.B.) is delivered to the pre-forming feed of the dryer, from a continuous filter. ❷ Coming to the hopper of the Proctor rolling extruder feed, in this highly moist state, the material is forced through a perforated plate by rolls moving back and forth, and deposited onto the conveyor of the dryer in spaghetti-like extrusions. This particular Proctor pre-forming feed is ideally suited to the handling of clay, for the initial moisture content and the physical characteristics of this product are such that it will hold a definite shape after extrusion. ❸ Loaded to a uniform depth on the moving conveyor, the clay is conveyed through the drying chambers, where heated air at 212° F. is circulated *through* the bed of material. By forming the clay into these small, uniform shapes, more rapid diffusion is possible, which accounts for rapid drying and the uniformity of the finished clay. ❹ After 42 minutes of drying time, the clay, uniformly dried to a moisture content of 3.1% (B.D.W.B.) is discharged from the dryer at the rate of 4,160 pounds—or more than two tons (C.D.W.†) per hour. Clay, thus dried, in the form of small particles, is uniformly dried all the way through to the center of each particle. This makes possible rapid and complete dispersability in water and, therefore, makes the clay ideally suited to subsequent use.

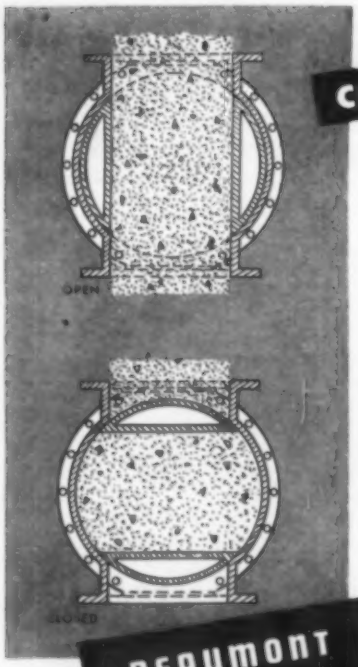
Proctor continuous conveyor drying systems, with pre-forming feeds, engineered to the individual product requirements, are in operation for a wide variety of wet-solids. It is safe to say that there are hardly two wet-solid drying problems exactly alike; that is why it pays to consult Proctor engineers early when you are considering drying equipment. On the basis of their experience they will be able to make laboratory tests on your product and then translate the results into a recommended system that will meet all of your requirements.

†Commercial Dry Weight

This is a case history taken from this new Proctor booklet

A new 12-page booklet on "Proctor Continuous Drying for the Chemical Process Industries" is available upon request. It contains many case studies showing the application for Proctor individually designed systems. Write for your copy of this informative booklet today.

PROCTOR & SCHWARTZ, INC., Philadelphia 20, Pa.



CONTROL MATERIAL FLOW

. . . with a Gate

THAT DOESN'T CLOG

Because the material in the gate body rotates with the machined rotor to cut off flow, Beaumont Rotary Gates are always easy to open and close. And, when the gate is open, there is no restriction to flow since the rotor opening is the same diameter as the pipe.

Beaumont Rotary Gates are quick acting, dust-tight and can be used at any angle for such fine materials as soot, cement and lime. They are made from any practical material—stainless steel, aluminum alloy, cast iron, nickel, etc. in sizes ranging from 4" to 12".

Many chemical plants throughout the country are finding it economical to standardize with Beaumont Rotary Gates. Why not do the same? Request complete information.

BEAUMONT BIRCH *Company*

1510 RACE STREET • PHILADELPHIA 2, PA.

Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

COSTLY HUMAN ERRORS ELIMINATED WHEN YOU MEASURE VALUABLE STORED LIQUIDS With

LIQUIDOMETER *Tank Gauges*

FOR GAUGING LIQUIDS OF ALL KINDS
100% AUTOMATIC
APPROVED BY UNDERWRITERS' LABORATORIES

WRITE FOR COMPLETE DETAILS

"LIQUIDS WORTH STORING ARE WORTH MEASURING"

THE LIQUIDOMETER CORP.
36-29 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

inter-tube space became restricted because of slag, the operators speeded up the induced draft fan till a blowtorch effect was attained which blistered still further the tubes that were starved of water. It required a very long time but eventually the boys learned to burn the most offensive coal that Mac could find and still avoid both slag and neighborhood reverberations.

SOFTENING WATER for boiler feed perplexed one of the old fellows beyond comprehension. Occasionally he charged the chemical tank with water and then forgot to add the chemicals. Once while he was wool gathering, a dose of sugar came down with the condensate and contaminated the feed water tank. The Micromax indicated the arrival of the sugar but the operator in his confusion tested with distilled water instead of the prescribed reagents and found no contamination. By the time the sugar reached the boiler, he discovered his error and started to swing the feed pump supply to the standby tank of fresh feed water. He got as far as the closing of the valve under the contaminated tank but forgot to open the other one. Directly the feed pumps oversped and kicked out. Quick action on the part of the fireman saved the day. A high speed boiler spewing out 125 tons of steam per hour cannot run long without a feed pump. Many more thoughtless performances are recorded in the log and it is amazing to note the promptness with which a few faithful leaders without experience (or B.S. degrees) sensed errors and avoided serious upsets.

WHILE THE EXPERTS were groping for a remedy for the blistering tubes, the boys maintained nearly 100 percent availability by installing new tubes furnished by the builder in alternate boilers on Sunday afternoons. On a Saturday afternoon when the boilers gave no signs of distress, Billy announced his desire to absent himself on the morrow to participate in the early mass. The peaceful ritual induced contentment but his mind was on the boilers. Suddenly some awkward parishioner splashed a book on the floor. Reflexively Bill jumped up and was about to beat it for the feed pump when consciousness returned and he resumed his pious attitude.

THE REMEDY for the cantankerous tubes was a baffle inside of the drum to constrain the flow from the water wall and direct it through the starved circulating tubes. This anticipated the present practice of omitting the intermediate drums and leading the long water wall tubes directly into the steam separating drum at the top. However

NICHOLS WEDGE

MULTIPLE HEARTH FURNACES

The performance records of thousands of Nichols Herreshoff-Bethlehem Wedge Multiple Hearth Furnace installations throughout the world have earned them an enviable reputation in the chemical, metallurgical and allied industrial fields during the past six decades.

Peak performance is assured, for each installation is designed to meet the particular requirements of the customer. Long experience, correct design and meticulous construction are all successfully combined to secure efficient and economical operation.

Nichols Herreshoff-Bethlehem Wedge Multiple Hearth Furnaces are unsurpassed for roasting, calcining, drying and revivifying ores, concentrates, sludges, etc.

Our engineering services covering plant or pilot plant design, incorporating furnace equipment for thermal processing provide a competent source for consultation or engineering undertakings. Bulletins on request.

NERCO

NICHOLS ENGINEERING & RESEARCH CORPORATION

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THE SELECTOLS?

...A group of catalysts designed for the hydrogenation of all edible fats and oils.

SELECTOL A —for selective hardening of high quality edible products at *low* temperature.

SELECTOL AB —for rapid hardening of edible type oils in the *higher* temperature ranges.

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Factory and Laboratories—Boonton, New Jersey

Samples SENT ON REQUEST

The RESISTOLS, companion products of the SELECTOLS —for the hardening of fish oils, tallow and all difficult conditions of glyceride oil hydrogenation.

E. F. Drew & Co., Inc.
15 East 26th Street, New York 10, N. Y.

Please send sample of SELECTOL _____

Please send sample of RESISTOL _____

Have your representative call _____

NAME _____

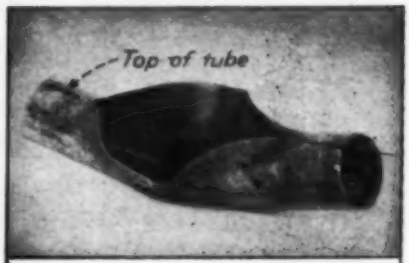
FIRM _____

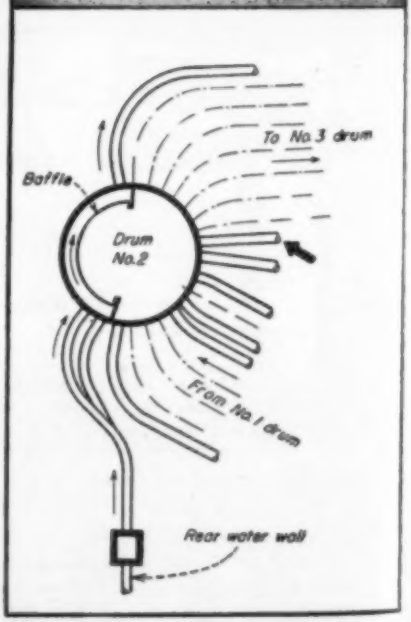
ADDRESS _____

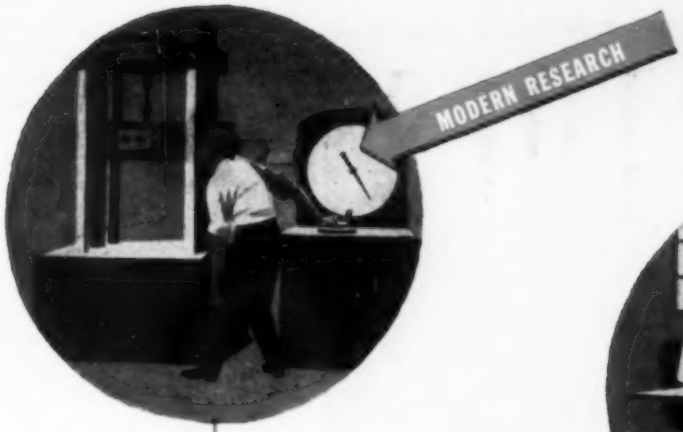
we retained the advantage of large water capacity. Each baffle cost $250 and a Sunday's work for the boiler makers. Thereafter tube difficulties abruptly ceased and we were on the way to overcome all of the children's diseases. The low prices prevailing in '31 had given us a great advantage.

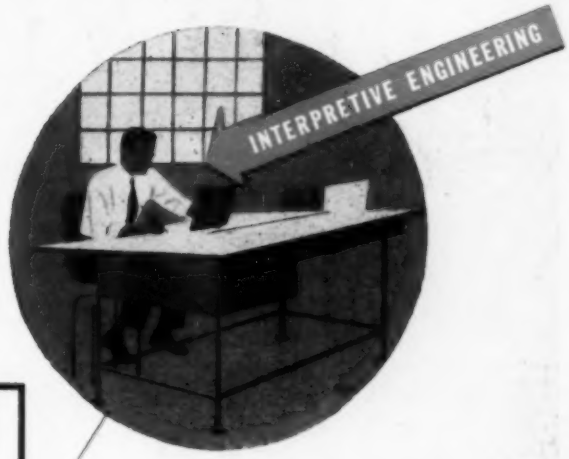
THE LAST TUBE FAILURE smeared the works with soot and directly thereafter two young salesmen blew in from the boiler builder's establishment bringing the engineer of a prospective customer. The engineer promptly got into action with the question, "Man to man, have you had any troubles with this installation?" We conducted him over the works and recounted all the hair-raising experiences, concluding each one with the remedy that had been found. Only the tube failure was not yet solved but the experts, having passed through the period of complex plans, had now arrived at a simple antidote that was to be applied next Sunday. The recital of the "troubles" caused the salesmen consternation. The possibility of a sale was lost by our brutal recital of

Failure of tubes between No. 2 and 3 drums was stopped by putting baffle in No. 2 drum. Sketch shows location of baffle. Arrow points to tube in photograph, which illustrates type of failure experienced in "water starved" tubes before baffle was installed









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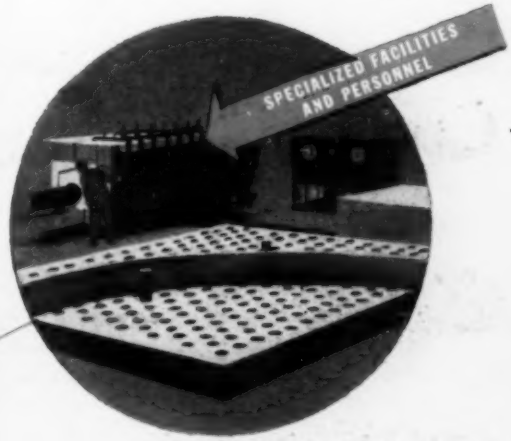
- ★ Reduction in Field Assembly Time



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WHENEVER PIPING IS INVOLVED

Packing for Lab. Columns Up to Giant Towers

Pictured above are four popular types of Knight-Ware Tower Packing. The partition and spiral rings are made of acid-proof stoneware. The Berl Saddles and Raschig Rings are made in stoneware and porcelain. These shapes and sizes provide a quality tower packing for nearly every chemical use.

All Knight-Ware Tower Packing is made from selected, washed and de-aired clays. Each type will withstand severe acid service, has a high crushing strength and will not spall. The one-inch Raschig Rings, for example, have shown an average of 125 lbs. in break tests.

Both Knight chemical stoneware and porcelain packings are dense but not glassy. When desired, porous packings can be made of either material.

Because of their large effective surface area, low resistance to flow and high loading capacity, the most popular all-purpose tower packing is Knight-Ware Berl Saddles. These are available in ¼", ½", ¾", 1" and 1½" sizes.

MAURICE A. KNIGHT • 105 Kelly Ave., Akron 9, Ohio

KNIGHT-WARE
CHEMICAL EQUIPMENT

the facts. However at his departure the engineer whispered his appreciation. He knew that the state of the art as of 1931 in dealing with our specification as to restricted dimensions as well as our demand for a large water volume in the way of drums, required extrapolation of experience. He had learned of the builder's disposition and technological ability to stand behind his guarantee and that's all he wanted to know. A little later his company issued an order to the builder of our boilers for equipment larger than ours.

THE BONEHEAD fireman tries to follow with the steaming rate when a bonehead sugar boiler turns on two or three pans simultaneously, each taking steam at 70,000 lb. per hr. The old boilers with their ponderous stokers and fans responded with a certain sluggishness that allowed the accumulator to function. On the other hand the new boilers with their high speed pulverizers and fans were automatically controlled to hold the 400-lb. pressure constant and supply process needs through the reducing valve instantaneously without recourse to the accumulator. A device was evolved to control the rate of change in the setting of the 400-150-lb. reducing valve and the consequent firing rate from the position of the accumulator. In any case the 150-lb. pressure was protected against a drop below 125 lb. by the double impulse valve that supplies the accumulator and process. However, the proposed control was too complicated and besides it tended to discourage operator alertness. It took a long time to learn that a sudden severe jolt in the steaming rate sent a slug of water into the turbines which now and then took out a blade or two. The turbine builder developed new and stronger wheels and by the time he had almost achieved resistability to the irresistable force, the operators learned to avoid the abuse.

AN AUTHOR contemplates the completion of a great work and grows sentimental. He ascribes the inspiration to his wife or mother—a noble deed. On the other hand an industrial plant engineer, devoid of sentiment, acknowledges his debt to the public service plants. These have tried-and-erred, leap frogged failures, and at heavy costs learned how to do many things and how not to do them. The information was generously exposed in the power journals to all the brethren. The cost of full size research, whose results were freely available to us in 1931, is represented by bonded indebtedness which in many cases covers installations junked long before the debt was paid.

NAMES IN THE NEWS

D. E. Pierce

C. L. Faust

Chester Knowles

David E. Pierce is now chief engineer of General Aniline and Film Corporation. His work embraces all divisions of the corporation including the Ansco Film and Camera Division and the Ozalid Machine and Sensitized Materials Division. For the past five years Mr. Pierce has been chief engineer of the General Aniline Works division of the company.

Robert A. Ruehrwein has been promoted to research group leader in the central research department of Monsanto Chemical Co., Dayton.

Glenn T. Seaborg has been awarded the $1,000 American Chemical Society prize in pure chemistry for 1947. The prize, given annually by Alpha Chi Sigma, will be presented at the fall meeting of the American Chemical Society in New York.

R. W. Trullinger, chief of the office of experiment stations in the Department of Agriculture, has been appointed to serve also as assistant administrator of Agricultural Research in association with W. V. Lambert, administrator, and Byron T. Shaw, assistant administrator.

Howard S. Turner has accepted a position with the Research and Development Division of the Pittsburgh Consolidation Coal Co. in Pittsburgh, Pa.

Eugene M. McColm has been appointed technical director of the plantation division United States Rubber Co.

Charles L. Faust, supervisor of electrochemical engineering research at Battelle Memorial Institute, Columbus, was elected vice president of the Electrochemical Society at the society's meeting last month.

Jack H. Mitchell, Jr., formerly connected with the Chemical Warfare Service Technical Command, has resigned from the Air Reduction Co. to take charge of the Food Section, Biochemistry Division, of the Southern Research Institute, Birmingham, Ala.

Linus Pauling, director of the Gates and Crellin Laboratories of Chemistry at the California Institute of Technology, has been awarded the Theodore William Richards Medal of the Northeastern Section of the American Chemical Society.

Walter J. Wyatt of the National Bureau of Standards is now in Germany where he will examine and coordinate documentary materials on the German staple fiber industry for the Office of Technical Services.

Doyle D. Buttolph has been appointed manager of the mechanical equipment division of Phillips Petroleum Co., Bartlesville, Okla.

Harold VonThaden, vice president of the Robins Conveyors Division and a director of the parent company, Hewitt-Robins Inc., is in Europe to transact business and engineering matters for the company in England and on the Continent.

Chester L. Knowles has announced the organization of Knowles Associates, a group of chemical, process, and design engineers with offices at 19 Rector St., New York. Dr. Knowles was with the Dorr Co. for many years, and more recently was technical director of the Process Equipment Division of General American Transportation Corp. Among the engineers associated with the organization are **O. R. Kuster** who resigned as chief engineer of General American's Process Division and **R. C. Ried,** formerly with the Valley Forge Cement Co. and the Separation Process Co.

Edwin M. Ott, chemical engineer in the market research department of the Pennsylvania Salt Manufacturing Co., has been named assistant manager of market research.

Glen H. Schafer has resigned from the Armour Research Foundation, Chicago, and become associated with the Chas. A. Krause Milling Co. as chemical engineer.

Raymond E. Horn, formerly vice president and director of sales, Abbott Laboratories, Chicago, has been elected president and general manager succeeding the late Rolly M. Cain.

Richard P. Harris of Norwalk, Conn., has been appointed factory manager of the electroforming department of United States Rubber Co. at Detroit.

Robert D. Juve has been appointed coordinator for the Goodyear Tire and

CORROSION RESISTANCE
That's more than skin deep

HAVEG

IS

NOT A LINING
NOT A COATING

but a Structural,
Non-Corrosive Material
ALL THE WAY
THROUGH

Scratch the surface—or gouge out a chunk—and you'll still find HAVEG process equipment fully resistant to the attacks of corrosion. Haveg is resistant to practically all acids, bases and salts, as well as chlorine, many solvents and other chemicals.

Haveg equipment, either standard or built to order, is adaptable for tanks, blowers, agitators, valves, piping, pumps, towers, coolers, fume ducts, hoods and many other shapes.

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CLEVELAND CHICAGO DETROIT LOS ANGELES

Rubber Company. His duties include the coordination of research, and end-use activities related to various synthetic rubbers.

B. K. Brown

Bruce K. Brown has been elected president of the Pan American Petroleum Corp. and the former president, **Robert E. Wilson,** is now board chairman of Pan-Am, a subsidiary of Standard Oil Co. (Indiana). Mr. Brown will continue as a vice president and director of the parent company. Coincident with Mr. Brown's election, it was

J. K. Roberts

announced that **Joseph K. Roberts,** general manager of research, who has been under Mr. Brown's general direction, would henceforth, as an independent department head, report directly to the chairman. Mr. Roberts is a former chairman of the petroleum division of the American Chemical Society and is at present a national director of the American Institute of Chemical Engineers.

John P. Clay has joined the Northeastern Wood Utilization Council, where he will serve as research coordinator.

Louis W. Munchmeyer has been elected vice president in charge of operations by Michigan Chemical

OHIO STATE CAPITOL BLDG., COLUMBUS

LONG LIFE QUALITY

Pleases Ohio Cities and Industries

Ohio, famed state of thousands of great industries and many prosperous and progressive cities now has in operation over 650 Layne high efficiency Well Water Systems. These Vertical Turbine systems are distinguished by their outstanding engineering features, extraordinarily high quality and absolute dependability in providing years and years of service.

Layne Well Water Systems are world famous for low operation cost. Furthermore they are so sturdily built and correctly installed that little or no upkeep expense is necessary.

For nearly 70 years Layne has pioneered in Well Water Systems and Vertical Turbine Pumps. No other make, in all the world compares with their high standards of perfection.

For further facts, catalogs, bulletins, etc., address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tennessee.

PUMPS For

Wells—Lakes—Rivers—Reservoirs—Irrigation Projects—are obtainable in sizes from 40 to 16,000 gallons per minute, powered by electric motor, V-belt or angle gear drives. Write for Pump Catalog.

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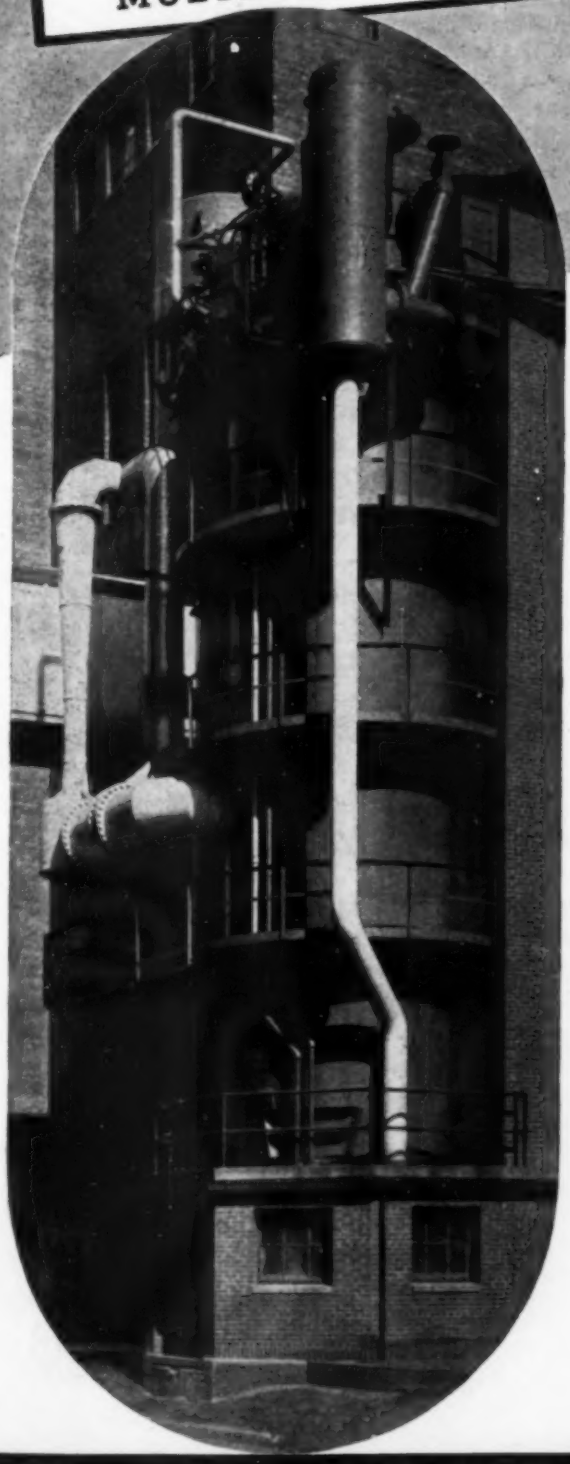
WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. * Layne-Atlantic Co., Norfolk, Va. * Layne-Central Co., Memphis, Tenn. * Layne-Northern Co., Mishawaka, Ind. * Layne-Louisiana Co., Lake Charles, La. * Louisiana Well Co., Monroe, La. * Layne-New York Co., New York City * Layne-Northwest Co., Milwaukee, Wis. * Layne-Ohio Co., Columbus, Ohio * Layne-Pacific, Inc., Seattle, Wash. * Layne-Texas Co., Houston, Texas * Layne-Western Co., Kansas City, Mo. * Layne-Western Co. of Minn., Minneapolis, Minn. * International Water Supply Ltd., London, Ont., Can. * Layne-Hispano Americana, S. A., Mexico, D. F.

GUARDITE

MULTI-STAGE EVAPORATIVE COOLER



Eliminates DOUBLE PIPE COOLERS

These coolers are equipped with automatic cleaning and sterilization features set at pre-determined intervals. Cleaning or sterilization occurs while cooler is "on stream." All internal surfaces are accessible for inspection and cleaning during periodic shut-downs. Designed for either continuous or batch operation to cool from as high as 360°F. to as low as 60°F. All operations are automatically controlled to minimize operator attention.

There are no moving parts to wear. These units can be furnished in sizes to meet your requirements and fabricated of the proper materials to meet your conditions. When writing please state kind and quantity of material to be cooled and temperature range, amount and temperature of cooling water available, steam available and pressure.

We will be pleased to give complete information as to operation and costs.

The GUARDITE CORPORATION

Vacuum Process Engineers

332 S. MICHIGAN AVENUE • CHICAGO, ILLINOIS

NOW! AN I★P★E TURBINE AGITATOR

FOR BATCH AND CONTINUOUS OPERATIONS!

★ Violent agitation in a wide range of liquid-liquid viscosities, solid-liquid suspensions and gas absorption.

★ Specially designed right angle drive eliminates step bearing—eliminates bearing trouble, particularly on stainless steel equipment.

★ Horizontal motor and right angle gearing allow for low head room installation.

(WE DELIVER ON TIME!)

★ No oil leakage on the vertical shaft.

★ Units engineered to YOUR particular application.

★ Specially designed blades to give downward and radial motion—ideal for dish bottom tanks.

Designed for a wide variety of chemical processes, our new I★P★E Turbine Type Agitator is particularly effective in suspending solid materials in light viscosity liquids. *Each* installation is engineered to your manufacturing process.

We also design and build *complete* equipment, using these agitators for batch and continuous operations in chemical and other processes . . . and DELIVER ON TIME.

Why not have I★P★E analyze your production process—make suggestions that will help you step up output—*help you meet today's heavy orders.* No obligation. Write, phone, wire today!

INDUSTRIAL PROCESS ENGINEERS

"Special and Standard Process Equipment Engineered to Your Requirements"

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WEST NEW YORK, N. J.

Corp. of Saint Louis, Mich. Mr. Munchmeyer joined the company in 1945 after serving during the war period as a Colonel in the Chemical Corps. Prior to the war he was connected with the Du Pont company.

Vladimir C. Sekera has recently returned to the laboratories of the Commonwealth Edison Co. of Chicago, after being released from active duty as a Lieut. Colonel with the Army.

J. J. Grebe

John J. Grebe, director of physical research, Dow Chemical Co. received the sixth annual John Wesley Hyatt Award in the plastics industry in Detroit, April 23 for his company's work in production and polymerization of pure styrene. He cited in particular the outstanding achievements of his colleague, **Robert R. Driesbach**, who was awarded the Hyatt silver medal.

Chester A. Roush, Jr., has become associated with Edgar A. Rogers, Chattanooga, Tenn., whose business is the analysis of process plant requirements and the application of equipment.

Theodore L. Swenson has resigned his position as special assistant to the Bureau of Agricultural and Industry Chemistry, Department of Agriculture, to head the food technology section of the Stanford Research Institute.

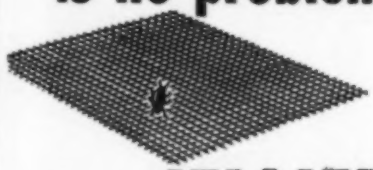
A. J. Still, formerly with the Mallinckrodt Chemical Co., has joined the staff of the Department of Chemical Engineering at the University of Alabama as an Associate Professor. **Ab Flowers**, formerly with the Republic Steel Corp., Gadsden, Ala., joined the Department as an instructor.

OBITUARIES

Walter D. Pheteplace, 74, a member of the board of directors and former president of The Pfaudler Co., died March 22.

MESH SIZE

is no problem



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For quality wire mesh — contact Jelliff — makers of wire mesh products for over sixty years. Commercial sizes available in standard lengths of 100 feet and widths of 24 to 72 inches. Meshes of specified gauge and weave made and cut to order. Available crimped, calendered and rolled. Jelliff engineers keep abreast of current developments in new alloys, coatings and processes and apply them when studying your requirements. For best results and maximum economies, look to Jelliff.

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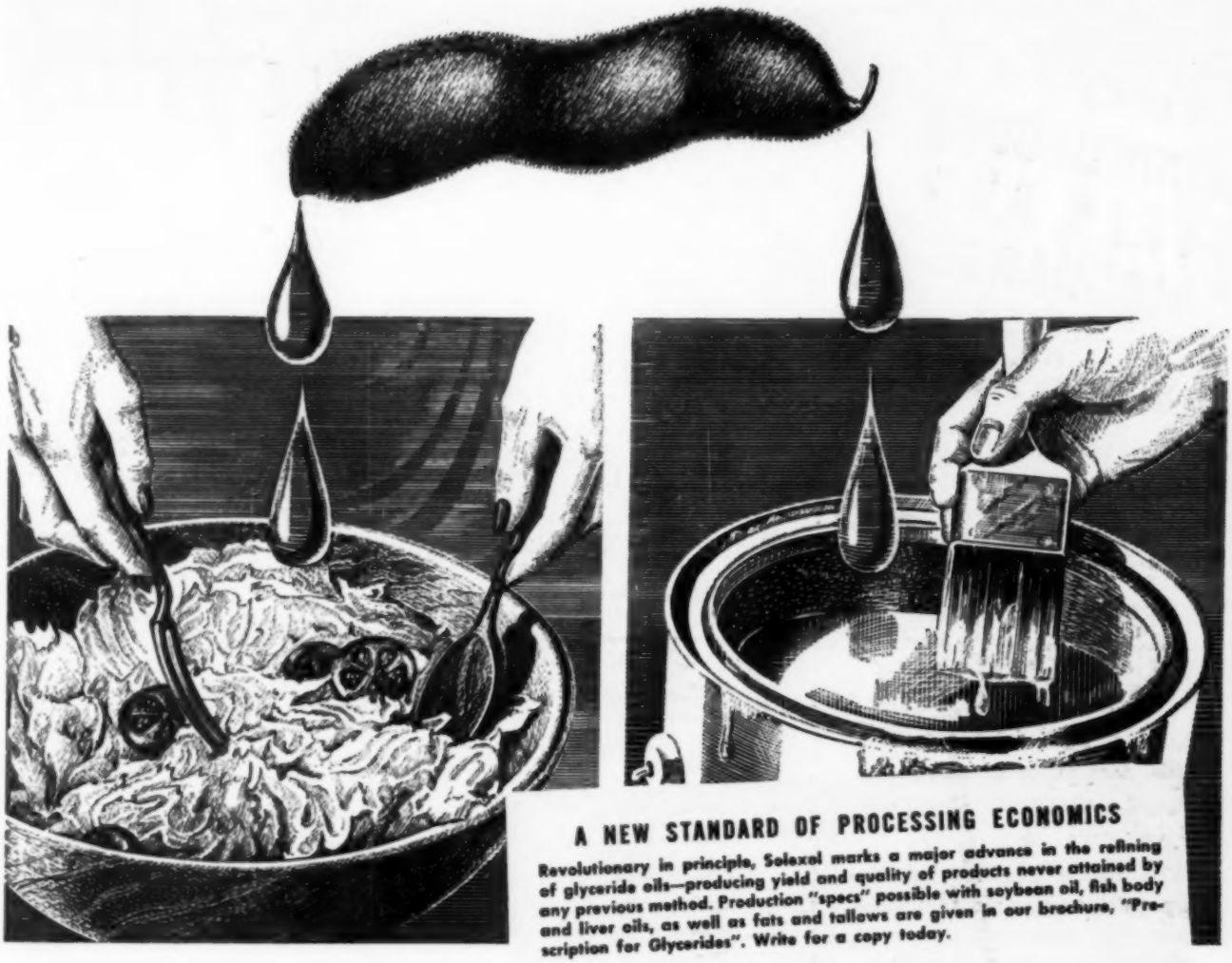

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Revolutionary in principle, Solexol marks a major advance in the refining of glyceride oils—producing yield and quality of products never attained by any previous method. Production "specs" possible with soybean oil, fish body and liver oils, as well as fats and tallows are given in our brochure, "Prescription for Glycerides". Write for a copy today.

MAKING A MIRACLE WORK BETTER

A few years ago soybean oil promised to be the miracle solution to a world-wide shortage of vegetable oils.

But somehow the miracle didn't quite materialize.

What happened is that conventional refining methods were unable to cope with the complex structure of soybean oil – unable to separate the various substances in a way that met exacting specifications for different products.

Today, however the story is different—thanks to the revolutionary new Solexol Process which separates various components in all glyceride oils *according to molecular weight and structure*—without chemical or thermal side reactions.

From soybean oil Solexol produces edible products with flavor stability never before attained commercially. Other fractions extracted from the same soybean oil produce paint oils superior to linseed oil in quick-drying properties—and still other fractions, such as lecithin, are valuable in the manufacture of pharmaceuticals and cosmetics.

What Solexol has achieved with soybean oil is typical of the vast new opportunities this process opens in the refining of all vegetable, animal and marine oils—to more exacting specifications and at less cost than ever before. For full information write: Glyceride Processes Division, The M.W. Kellogg Co., 225 Broadway, New York 7, N. Y.

SOLEXOL

Decolorizes, separates, extracts, concentrates and deodorizes;

VEGETABLE OILS

Soybean	Cottonseed	Tall
Linseed	Peanut	Other similar types

ANIMAL PRODUCTS

Tallows	Waxes	Greases

MARINE OILS

Fish body oils and liver oils having widely different physical, chemical and vitamin-potency characteristics.

FATTY ACIDS From all sources

Licensed jointly by The M. W. Kellogg Co. and The Chemical Foundation, Inc.

GLYCERIDE PROCESSES DIVISION

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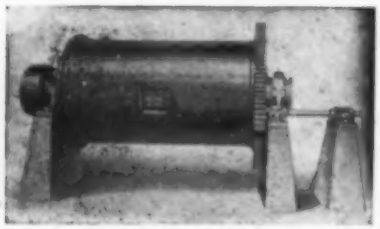

PAUL O. ABBE

TUBE MILL

Illustrated is one of a big range of Paul O. Abbé Tube Mills, that make grinding and mixing a continuous operation.

●

The range includes laboratory units, and production mills up to 7'6" diameter. Length of cylinders are made to meet individual requirements.

●

Materials are fed continuously at one end of the horizontal cylinder, and are discharged through the trunnion at the other end, after coming into contact with the entire bulk of the grinding medium.

●

Little maintenance is required aside from occasional lubrication.

●

Air separators, screens, and other classifiers can be used for a closed circuit system, returning any coarse particles to the mill for additional grinding.

PAUL O. ABBE

375 Center Avenue
LITTLE FALLS, N. J.

Robert R. Tanner, 51, president of the Tanner Chemical Co., Detroit, died of a heart attack March 30.

Harry C. Beaver, 70, vice-chairman of the board of directors and former president of the Worthington Pump & Machinery Corp., Harrison, N. J., died in N. Y. April 2.

Milton R. Sheen, 63, president and cofounder of the Milton Roy Co. died in Glenside, Pa., Apr. 3.

E. L. Berry, 52, Link-Belt vice-president in charge of production, died of a heart attack in Chicago, April 3.

Edwin B. Peet, 64, sales manager for the Cameron Can Machinery Co., Chicago, died April 4.

Herbert F. Whalen, group leader of lacquer research at Monsanto Chemical Co.'s Merrimac Division plant, died in Everett, Mass., on Apr. 9.

Monsanto Men and Women Who Lost Their Lives at Texas City

Armatta, L. J.
Attwood, J. B.
Bonewits, Harold E.
Boudinot, R. E.
Brown, L. J.
Byrd, Lemare
Coburn, Hilton T.
Coffman, L. M.
Comstock, Charles
Cox, Henry E.
Czolbe, C. H.
Davis, C. E.
Davis, J. H.
Driskell, Chester
Evans, Drew M.
Forman, Leve
Fraser, Wm. H.
Fuller, John B.
Gates, L. A.
Gilcrease, C. K.
Gillis, Thurman
Gipson, Billy J.
Harrell, J. A.
Hawkin, Thomas B.
Haymon, Woodrow
Hays, Dolphin, W.
Herrin, R. J.
Herring, Les
Hext, Doyle
Hutchins, L. C.
Jerkofsky, A. W.
Johnston, F. F.
Keyes, A. L.
Krause, Charles C.
Lacquement, Willie O
Langley, J. W.
Lewis, Taft B.
Luhing, Joseph C.
Luther, Frank J.
Masters, A. D.
Merriam, B. F.
Miller, T. R.
Morrison, J. J.
McAllen, P. G.
McFarlane, Graham
McGrew, Edith W.
McIntyre, Thomas F.
McNallen, Paul J.
Nichols, Frank H.
Nutt, C. M.
Oliver, L. A.
Parker, J. F.
Richardson, Joe
Rowley, W. W.
Root, C. R.
Ruecker, F. A.
Russ, Glen F. Jr.
Scoselia, J. A.
Scott, Jerry
Southerland, R. D.
Starr, Ernest
Stidman, L. D.
Tyson, Merrill
Valigura, W. J.
Walker, F. A.
Walker, Floy M.
Wells, Bruce B.
Wells, Crofton A.
White, Dallas
Womack, C. A.

Before You Buy ANY Domestic Water System
See the PEERLESS Water King

Exclusive
Water King
Features

SIMPLIFY WATER PUMPING—LOWER COSTS

THE MOST ADVANCED PUMPING PRINCIPLE IN THE LAST 10 YEARS

"Magic Wings to Water Lift"

The trouble-free simplicity of the patented Peerless Water King is a real innovation in water pumping. Here is the ideal pump for domestic and light industrial water systems, meeting every requirement for simplified pumping at lower costs.

The Peerless Water King is the pump with "Magic Wings to Water Lift." The Water King is a shallow well pump, embodying an exclusive "magic" pumping element: a hard chrome rotor revolving in a rubber stator that draws water upward and forces it into pressure tank—the most advanced pumping principle in the past 10 years. Capacities: 275 to 860 g.p.h., against pressures up to 40 lbs. *There are no parts of the pump underground.* 100% automatic. Easily installed over the well or offset. Pumping element highly resistant to abrasive and corrosive action. Finely engineered—Compact—Quiet—Trouble-free.

The Peerless Water King

Covered by Peerless Patent 2,346,428
Mfd. under R. Moineau's U. S. Letters Patents 1,892,217-2,028,407 — Reissue 21,374 and Canadian Patent 352,574; Robbins & Myers, Inc., Sole U. S. and Canadian Licensee.

PLAN WITH PEERLESS

Peerless has a pump for all your needs for water—from 10 to 220,000 gallons per minute! Write to Peerless factory or district office for literature and name of nearest dealer.

Descriptive Bulletins available.

2 PEERLESS DOMESTIC WATER SYSTEMS

A PEERLESS JET SYSTEM, TOO

For Deep or Shallow Wells.
Capacities: 120 to 7500 g. p. h.
Lifts up to 120 feet.

This amazingly simple and compact Peerless Jet Water System produces all the water you want for normal light industrial operating requirements. It is a pressure system, entirely automatic, and occupies little more space than an electric motor. A Peerless Jet Water System offers a lifetime of trouble-free water service at minimum cost. Can be installed over well or offset. Write for Bulletin B-155-1 describing Jet Water System in detail.

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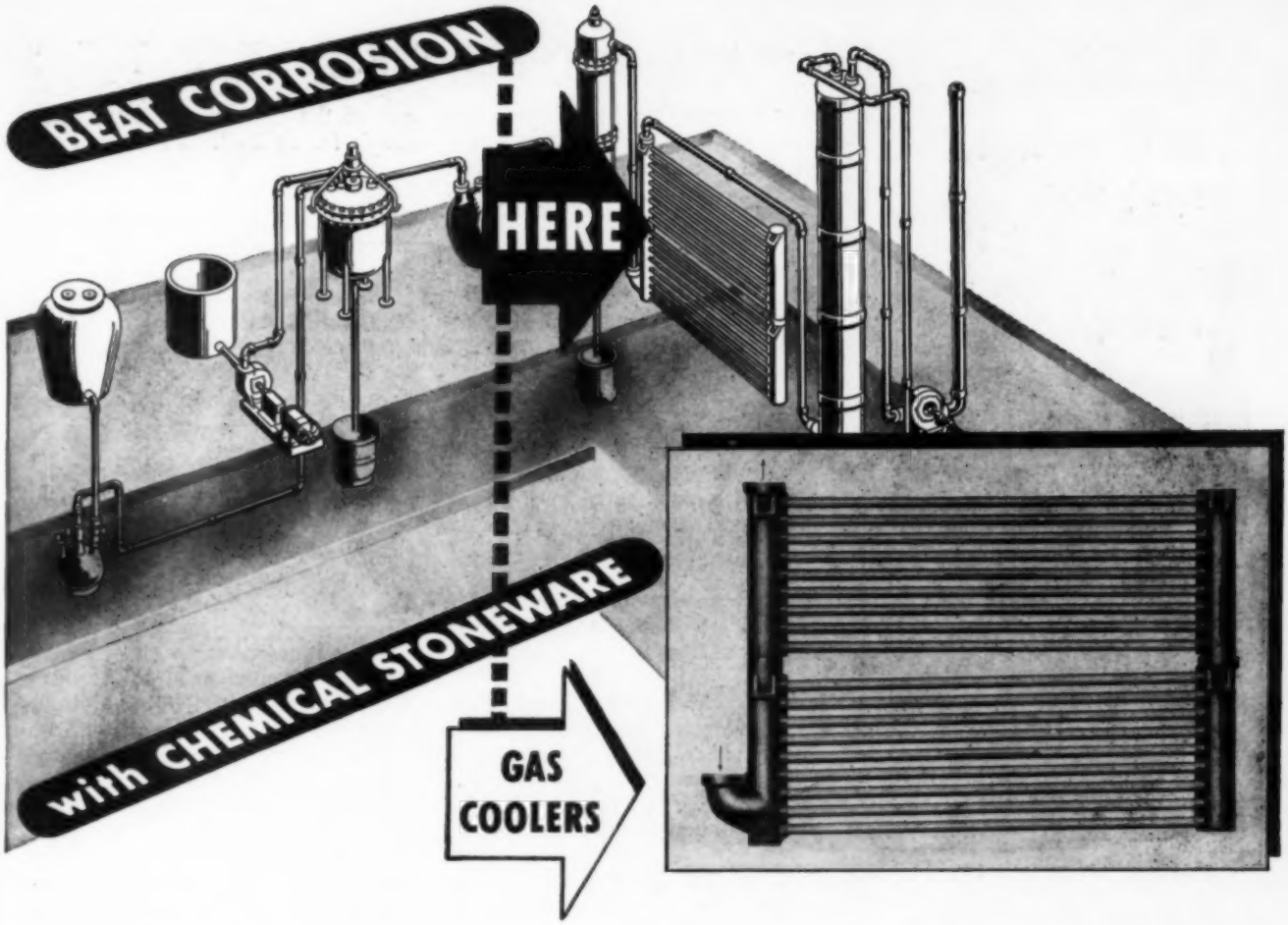
Food Machinery Corporation
Factories
Canton 6, Ohio — Quincy, Ill
Los Angeles 31, Calif.
District Offices
Canton 2, Ohio, Ardmore, Pa.; Decatur, Ga.
Dallas 1, Texas



For cooling Corrosive Gases equipment MUST: (1) be resistant to acid fumes, (2) have relatively high heat transfer, (3) be of simple construction for economical installation and maintenance.

General Ceramics Coolers pictured above are (1) made of high grade Chemical Stoneware and are not only corrosion resistant but corrosion proof against all strong acid gases with the exception of Hydrofluoric, (2) are manufactured with heat transfer tubes fabricated of a special stoneware body which not only has superior properties of thermal shock resistance and physical strength but has 3 TO 4 TIMES THE THERMAL CONDUCTIVITY of standard stoneware, (3) are designed for chemical engineers by chemical engineers. They offer sturdy simple construction featuring accessibility of all parts and joints, easy cleaning and convenient tube replacement which does not require dismantling of the entire unit. The coolers pictured above are widely used in the chlorine industry where they have successfully withstood the stringent action of hot (up to 200° F.) saturated chlorine from the cells. Varying capacities can be handled by using one or a multiplicity of units and an installation of General Ceramics tubes for gas coolers with B-41 tubes interconnected by SP-32 piping, valves and fittings, is your guarantee of a satisfactory gas cooling operation.

Send for Circular A which illustrates this equipment and, if you have a specific problem, a letter from you with complete details will result in a proposal giving our recommendations.

2779

GENERAL CERAMICS AND STEATITE CORPORATION
CHEMICAL EQUIPMENT

BUFFALO: 610 Jackson Bldg. CHICAGO: 20 N. Wacker Drive
LOS ANGELES: 415 So. Central Ave. PORTLAND 5, ORE.: 410 New Fliedner Bldg.
SEATTLE: 1411 Fourth Ave. • SAN FRANCISCO: 598 Monadnock Bldg. • TACOMA: 417 Tacoma Bldg.
MONTREAL: Canada Cement Bldg. • TORONTO: Richardson Agencies, Ltd., 454 King St., West
VANCOUVER, B.C.: Willard Equipment Ltd., 860 Beach Ave.

In addition to the manufacturing facilities of the Chemical Equipment Division those of the Insulator Division are also available for handling ceramic problems in all branches of industry. General Ceramics & Steatite Corporation is therefore able to offer service covering all industrial applications of ceramic products.

General Ceramics
AND STEATITE CORP.
CHEMICAL EQUIPMENT DIVISION
KEASBEY, NEW JERSEY

Now available in Commercial Quantities

Petrolite

EMULSIFIABLE WAXES

Crown Quality 23

Crown Quality 36

THE PETROLITE EMULSIFIABLE CROWN QUALITY WAXES ARE:

- 100% petroleum derivatives, *not blends*
- Easily emulsifiable, forming stable, translucent Emulsions.
- Non-tacky, Wear-resistant and High Gloss . . .
- *ECONOMICAL TO USE*

NOTE THESE CROWN SPECIFICATIONS	Quality No. 23	Quality No. 36
Melting Point °F Minimum	185	185
Penetration 100 gms at 77°F	2 - 5	5 - 8
Color N.P.A.	4½ - 6	5½ - 8
Saponification Number	55 - 65	85 - 95
Acid Number	20 - 25	30 - 35

The Petrolite Emulsifiable Crown Quality Waxes are ideal for self-polishing wax formulations. Both are already in extensive commercial use. They have proved especially economical, especially when used to extend Carnauba and other scarce and costly vegetable waxes.

Samples, technical advisory service and complete price information is available at the Refinery or the Sales Office — WRITE NOW.

Petrolite

PETROLITE WAX

PETROLITE CORPORATION, LTD.
Wax Division
29 Broadway, New York 6, New York
Refinery, Box 390, Kilgore, Texas

13e

INDUSTRIAL NOTES

Foote Mineral Co., Philadelphia, announced two additions to its Exton Chemical division. They are William Ross Thomson and George Douglas Copeland.

Raybestos-Manhattan, Inc., Passaic, N. J., elected A. F. Heinsohn to the board of directors and John H. Matthews and O. H. Cilley vice presidents of the company.

Farrell-Birmingham Co., Inc., Ansonia, Conn., appointed D. K. MacLean export manager for all lines of machinery manufactured by the company. His office will be at the Ansonia plant.

Gardner-Denver Co., Quincy, Ill., elected E. F. Schaefer president of the company.

Prufcoat Laboratories, Inc., Cambridge, Mass., appointed United States Rubber Export Co., Ltd., exclusive export distributors for Prufcoat protective coatings and transparent waterproofing.

U. S. Steel Corp., Chicago, has appointed John T. Swift assistant manager of the U. S. Steel Supply Company's Twin City district works.

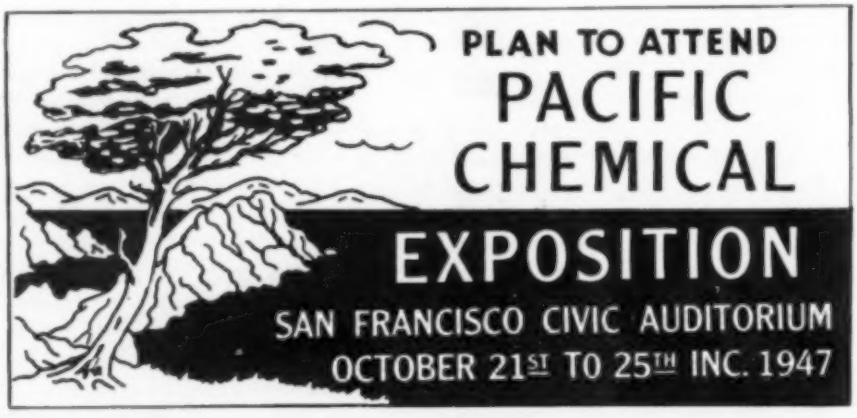
McQuay, Inc., Minneapolis, has named Blake Thomas assistant general sales manager.

St. Regis Paper Co., New York, has elected William H. Versfelt and Edward G. Murray vice presidents. Ashley D. Pace and Gurdon W. Wattles have been elected to the board of directors.

Reading Chain and Block Corp., Reading, Pa., has appointed Yarrington & Jones, Inc., Baltimore, as representatives to cover Delaware and Maryland, and York and Lancaster, Pa.

Eastern Industries, Inc., New Haven, Conn., has purchased the McIntyre Co., Newton, Mass. The McIntyre plant will continue to produce its own line of pumps and will also produce Eastern pumps. Key personnel will continue in their present positions.

Wyandotte Chemicals Corp., Wyandotte, Mich., has made the following changes and transfers: John M.



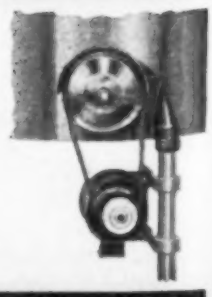
Portable or Side Entering AGITATORS

INCREASES the EFFICIENCY of Your Tank Installations—

Side-entering model (permanent installation) as illustrated easily installed on your present tank equipment. Portable, top-entering models also available for use on any tank. Three blade exclusively designed propeller—ball bearing shaft—built for a lifetime of trouble-free, efficient service.

FAST MIXING — COMPLETELY SANITARY—

Speeds up your mixing—saves time, money and effort. Does a more thorough job. Side-entering model has fool-proof seal into tank—no danger of oil leaking into tank. Portable models specially designed for sanitary use. Write for complete agitator catalog.



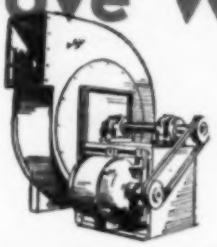
PROCESS EQUIPMENT ENGINEERS, Inc., Belding, Mich.

CONTROL DUST TO

1 Improve Working Conditions!

"Buffalo" EXHAUST FANS

These new highly efficient exhausters have smooth, all-welded housings. Bulletin 3576.

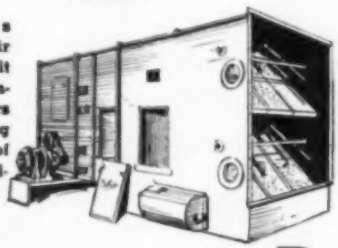


Control of dust in your plant or shop can make a big difference in working conditions! "Buffalo" Exhausters remove harmful dust, fumes, abrasives, etc., from the air—cut employee sickness and absenteeism to a minimum. "Buffalo" Exhausters require very little maintenance and make your power dollars go much farther.

2 Raise Product Quality!

"Buffalo" WET GLASS CELL AIR WASHERS

These units wash the air and filter it through spun-glass filters . . . removing over 98% of the dust. Bulletin 3457.

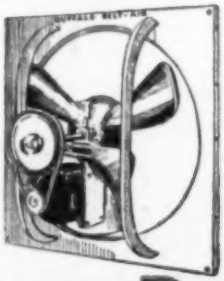


When your product must be kept free of air impurities, many manufacturers have found that "Buffalo" Wet Glass Cell Air Washers play a big part in maintaining uniform high quality. Besides keeping atmosphere free of practically all dust, these units can also provide humidification, cooling or heating, as desired . . . for further control of your product quality. For complete facts, write for Bulletin 3457.

3 Increase Production!

"Buffalo" DISC FANS

Available in belted or direct motor drive. "Buffalo" Breezo and Belt-Air Fans operate quietly and at negligible cost. Bulletin 3222-D.



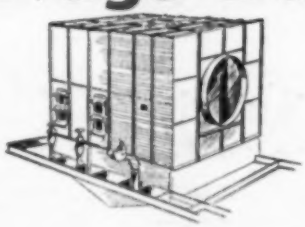
Many a ventilation system has its smoky, dead air spots . . . where production lags! Workers can't do their best in a stifling atmosphere.

By spotting "Buffalo" disc-type fans in these areas, you can bring live, fresh air to every worker very economically . . . clear the air of dust and fumes . . . and step up production. These "Buffalo" Fans are easily mounted on outside walls, where they do a steady, thorough job of drawing the bad air OUT. You'll find complete facts in Bulletin 3222-D. Write for it, for your files.

4 Salvage Dust!

"Buffalo AIR WASHERS

These air washers are available in several types, for collecting valuable or dangerous dusts.



Many industrial processes require thorough recovery of valuable by-product material in dust form. Here, you will find Buffalo Type "DE" and "TE" Static Washers the low-cost answer. Extra sets of scrubbing plates insure complete collection, in a settling tank, either manually or automatically flushed out. Facts on the several models will be found in Bulletin 3142-C. Write for your copy!

BUFFALO FORGE COMPANY

501 BROADWAY BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

Equipment For Dust Collection

AN INVALUABLE GUIDE AND REFERENCE BOOK

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Compiled by
LUDMILLA IGNATIEV CALLAHAM

Here is a complete and scientifically organized reference to 80,000 terms, with a comprehensive coverage of organic and inorganic chemistry, chemical technology and mineralogy. Also extensively covered are metallurgy, mining, geology, engineering, physics, botany, pharmacy, and the more common terms in agriculture, medicine, aeronautics, meteorology, and military science. In addition, the book includes those terms that are most frequently used by industrial technologists.

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Norcott from the Detroit territory to the Pacific division as sales representative for Michigan Alkali division and Natural Soda Products Co. Raymond C. Leonard replaces Mr. Norcott in Detroit.

Frederic C. Clark Associates, New York, has moved its office to 50 Church St.

Pennsylvania Salt Mfg. Co., Philadelphia, has appointed William P. Drake assistant vice president. Arthur F. Bixby, heavy chemicals salesman, has been transferred to the Pittsburgh office. C. W. Dermitt was recently moved to the Cincinnati office to become district manager.

Read Machinery Co., Inc., New York, has been merged with the Standard Stoker Co., Erie, Pa., and is now known as the Read Machinery division of the Standard Stoker Co.

Nopco Chemical Co., Harrison, N. J., is the new name of the National Oil Products Co.

Wedgeplug Valve Co., Inc., New Orleans, has expanded its sales organization to include the following representatives: Holbrook and Hunter, Boston; Garrett Burgess, Inc., Detroit; and R. George Ward, Philadelphia.

United States Stoneware Co., Akron, has made Herman H. Frahme a consulting ceramic engineer.

General American Transportation Corp., Chicago, has acquired the L. R. Christie Co., New York.

Hewitt-Robins, Inc., Buffalo, N. Y., has announced that the Hawaiian Equipment Co., Ltd., Honolulu, will be its distributor throughout the Hawaiian Islands. W. P. Sheehan vice president and general manager will direct the new company.

Titeflex, Inc., Newark, N. J., named Henry S. Elder vice president of the company.

Young Radiator Co., Racine, Wis., has added James A. Stahn to its staff as engineering representative.

Goodyear Tire and Rubber Co., Akron, appointed John W. Bear to the staff of the plastics and coatings department and assigned to the Philadelphia district.

B. F. Goodrich Co., Akron, announced that the new plant of American Anode, Inc., East Los Angeles,

The Zenith Pulp Press, with capacity up to 26 tons per hour, thoroughly dewaters wet pulps and slurries such as:

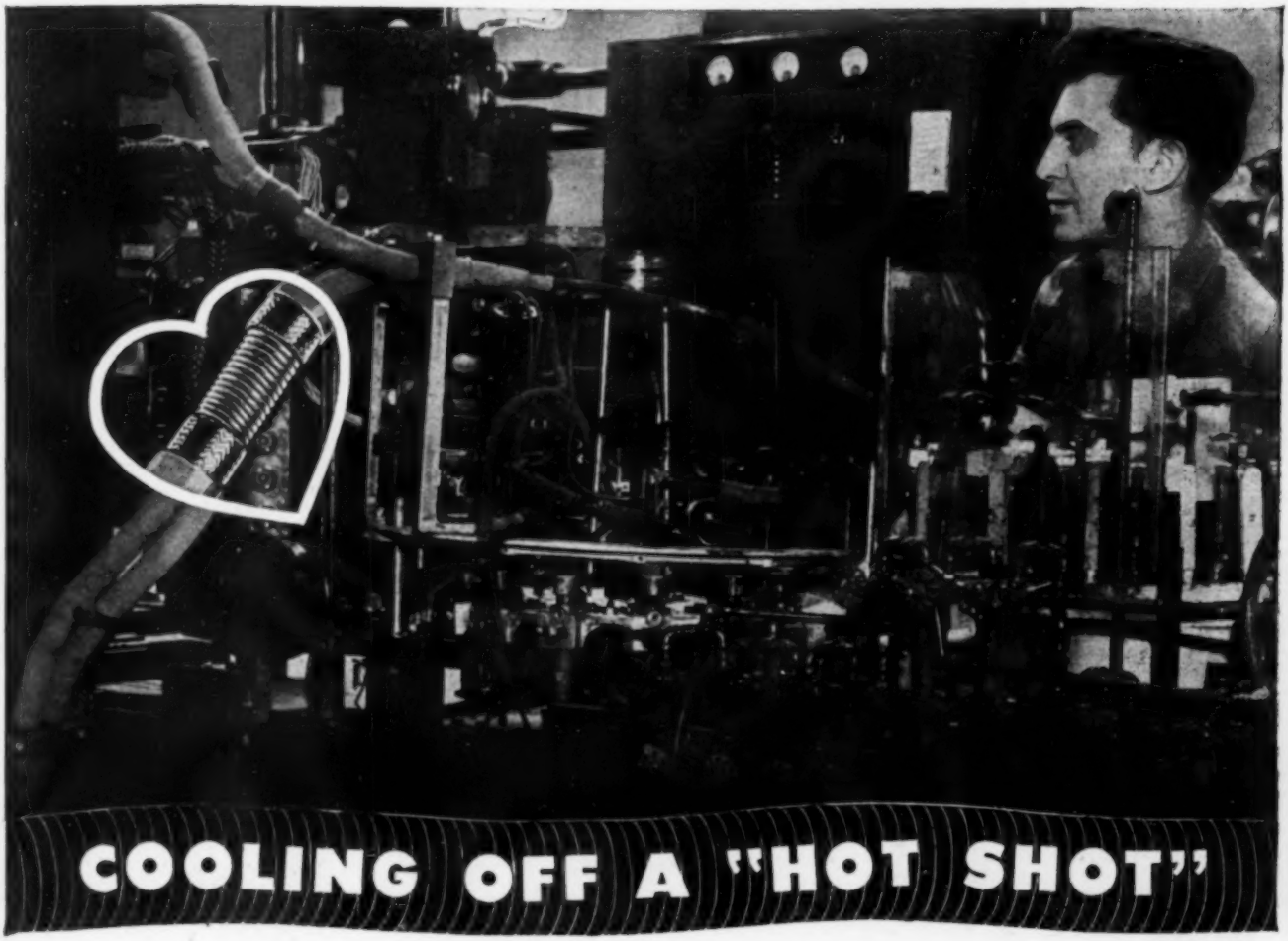
Beet Pulp • Citrus Wastes • Tomato Pomace • Cherries • Corn Fibre • Paper Pulp • Reclaimed Rubber, etc.

Heavy screw-type spindle applies smooth, continuous pressure, forces pulp or slurry against selective resistance. Rifle drilled resistors permit use of steam when necessary. Minutely perforated screens assure efficient drainage, hold pulp losses to minimum. Ball thrust bearings and oversize shaft bearings reduce power load.

New uses for the remarkably efficient, profitable Zenith Pulp Press are being constantly developed. An experimental press is available for trial in your plant.

Write for full information.

JACKSON & CHURCH CO.
SAGINAW, MICHIGAN



COOLING OFF A "HOT SHOT"

Penflex "Flexineering" solves problem of conducting and cooling a 3500-volt "shot" in vacuum tube plant.

One well-known vacuum tube manufacturer developed several powerful induction heat "bombarders" for forming the vacuum in radio tubes. A 3500-volt "shot" quickly generates 950°F. in the tubes . . . exhausts the air . . . forms a vacuum, speedily, efficiently.

But—a problem arose. They needed a good conductor to carry the "hot shot" to the machine head—one that could be kept cool, yet remain flexible. Various wiring arrangements and cooling devices were tried but each proved impractical. Then Penflexweld tubing was applied and—the problem vanished!

The copper construction of Penflexweld furnishes an ideal conductor, while cold water circulating through the tubing keeps it cool. Penflexweld flexes easily with constant machine motion. Wrapped rubber insulation protects operators from shock. The higher efficiency developed by the use of Penflexweld eliminated the need for larger and more expensive bombarder units.

Penflex "Flexineering" (the science of engineering each type of flexible metallic tubing to the particular problem) can help solve similar problems on production, maintenance, and product design in your plant. For helpful engineering service and a complete line of metallic hose and tubing from ⅛" I.D. to 30" I.D. in all types . . . for all uses . . . call on Penflex. Write today for additional data on the above case history.

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PORCELAIN FLOW RATE METER FOR CORROSIVE SERVICE

Aqua-Regia
Chromic Acid
Bromine
Iodine
And similar "tough-to-meter" fluids are readily handled.

The F & P Porcelain FLOWRATOR (variable-area flow rate meter) is unusually well-adapted for severe services.

Write for catalog 32

LABORATORY FLOW RATE METER

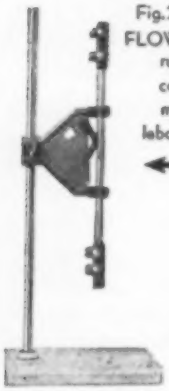

Fig. 27—All-Glass FLOWRATOR with rubber hose connections, mounted in laboratory stand

Fig. 735-BH—Master-Enclosed FLOWRATOR with leveling screw, spirit level and hose nipple connections

The F & P FLOWRATOR, variable area type flow meter, permits an instantaneous reading of the true flow rate. Each instrument is accurately calibrated at our factory for your exact requirements.

Liquid flows down to 0.15 cc per min. and gas flows down to 3.0 cc per min. can be measured with ease. All-glass meters are now sold at EVEN LOWER prices than prevailed during the war.

Write for catalog 32

FLOWRATOR
TRADEMARK
FISCHER & PORTER CO.
DEPT. 7F-18 HATBORO, PENNA.

Calif., began manufacturing operations in April. R. A. Lees is plant manager.

Pittsburgh Coke & Chemical Co., Pittsburgh, appointed R. M. Moore general sales manager and Alan S. Evans manager of the chemical sales division.

Bemis Bro. Bag Co., St. Louis, announced that operations will commence about September is the newly leased buildings in Jacksonville, Fla. L. L. Conrad will manage the new plant.

Tube Turns, Inc., Louisville, has moved the Chicago headquarters to the Fairbanks-Morse Building, 600 South Michigan Ave.

John A. Roebling's Sons Co., Trenton, N. J., appointed A. R. Robinson manager of the Seattle branch.

Bailey Meter Co., Cleveland, announced the appointment of the Portilla Corp. as its agent in Puerto Rico.

Pittsburgh Plate Glass Co., Pittsburgh, has made Walter T. Johnson New York district sales manager for the Columbia Chemical division.

Bryant Heater Co., Cleveland, has named Dudley & Garland New England representative for its industrial division.

International Paper Co., New York, has opened a branch office for the International Paper Products division in Syracuse, N. Y. W. A. Scholl is the new district manager. The office is located at 269 Erie Blvd., West.

Monsanto Chemical Co., St. Louis, has established a regional sales office at 140 Federal St., Boston, Mass.

Bailey Meter Co., Cleveland, has elected H. M. Hammond and P. S. Dickey to the position of vice president.

Handy and Harman, Inc., New York, has opened a new West Coast service plant. The new plant is located at 3625 Medford St., Los Angeles, Calif.

Abbott Laboratories, North Chicago, Ill., has elected Raymond E. Horn president and general manager. S. DeWitt Clough was reelected chairman of the board. Alfred W. Bays was made vice chairman. Edward A. Ravenscroft and Floyd K. Thayer are new members of the executive com-

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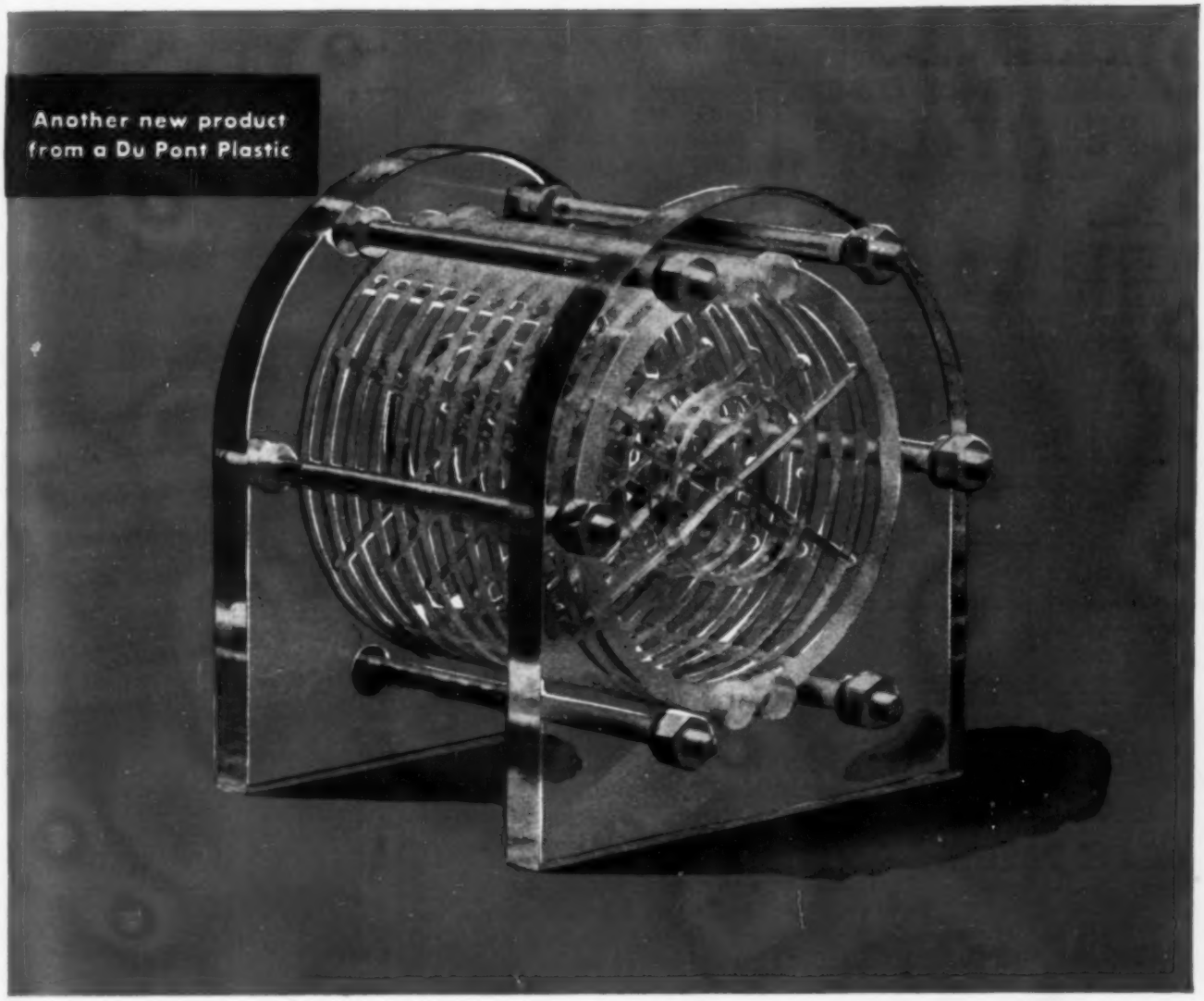

NEW DIALYSER OF DU PONT "LUCITE"*

NYLON HELPS CUT LAB EXPENSES

Bristled with Du Pont nylon, brushes for cleaning test tubes, flasks and other laboratory equipment withstand scrubbing, hot soapy water and a wide range of organic and inorganic chemicals. Nylon bristles outlast animal and other old-style bristles, save money on replacements.

Brushes above made by A. W. Justman Brush Co., Omaha, Neb.

HERE'S REAL HELP for teachers and research workers . . . an efficient continuous dialyser that permits demonstration of continuous dialysis and study of its use in specific problems.

Made of crystal-clear Du Pont "Lucite" acrylic resin, this dialyser consists of a number of circular cells separated by membranes of parchment, Cellophane or other suitable substance. The solution to be dialysed and the dialysing liquid—usually water—are fed into alternate cells, and the desired separation takes place after the solution has come into balance. The apparatus is easy to clean...long-wearing...inexpensive to maintain. It is already finding successful use in many colleges and research laboratories.

This is just one example of how "Lucite" and other Du Pont plastics provide opportunity for unique new designs and better service in equipment for the chemical and allied industries. Look to Du Pont plastics for improving existing equipment and planning the new. Write for literature. It will pay you to keep it handy in your files. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 105, Arlington, N. J.

"Webcell" Continuous Dialyser made by Brosites Machine Company, Inc., 50 Church Street, New York, N. Y.

*REG. U. S. PAT. OFF.

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REG. U. S. PAT. OFF.
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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

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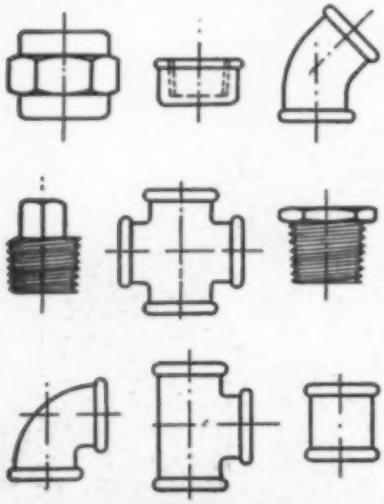
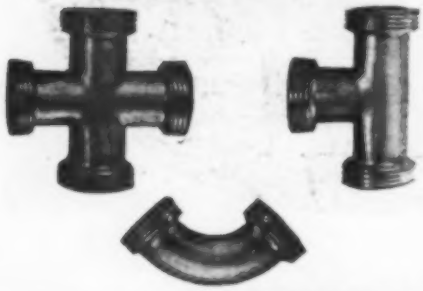
Stainless Steel (18-8)
PIPE FITTINGS
STANDARD I.P.S. THREAD

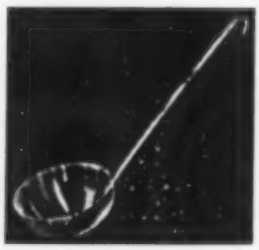


SANITARY
STAINLESS STEEL
FITTINGS



DIPPERS

72 oz. with 17" hooked handle. Also some one, two and four quart FLAT dippers.



PAILS

Seamless stainless steel. Capacities, 12 and 15½ quarts.

We carry a full line of filter paper. Also, Hose for all purposes. Send us a sample of your needs.

Immediate Delivery
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SIPHON SUPPLY CO., INC.
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mittee. George R. Cain, newly elected to the board, has been named secretary of the executive committee.

Pennsylvania Flexible Metallic Tubing Co., Philadelphia, has opened a warehouse and sales office at 4352 W. Harrison St., Chicago, and another in Los Angeles.

E. I. du Pont de Nemours & Co., Wilmington, announced the appointments of L. G. Seebach as manager of the Transfers Section of the Ammonia Department and Russell C. Weigel as sales manager of the Standard Products section.

International Minerals & Chemical Corp., Chicago, announced that Louis Ware, president of the company, has been elected to the board of directors of United States Gypsum Co.

Ladish Co., Cudahy, Wis., has established a new district office at 452 Spring St., N. W. in Atlanta, Ga., and discontinued its New Orleans office. W. W. Bowie, formerly manager of the New Orleans office will be in charge.

United States Steel Corp., Chicago, has appointed Walter A. Jayne assistant general superintendent of its Gary, Ind., works.

Marco Co., Wilmington, has made Woodrow F. Wilson assistant sales manager for all products. E. L. Kufler has been named sales engineer.

Titan Metal Mfg. Co., Bellefonte, Pa., has announced that the George S. Lacey Co., sales representative for the company has opened a new office at 526 South San Pedro St., Los Angeles.

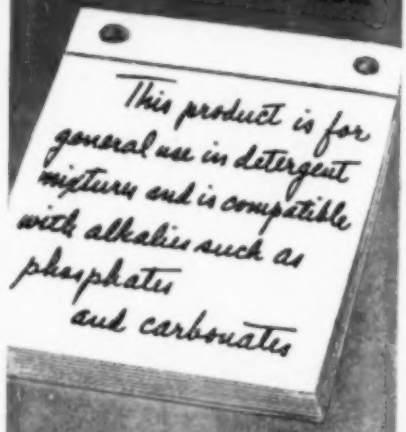
H. K. Porter Co., Inc., Pittsburgh, has moved its Quimby Pump division to Pittsburgh.

Jessop Steel Co., Washington, Pa., announced that the exclusive representative for the state of Wisconsin has been changed from L. E. Meidinger Co., Inc., to Bell Steel Sales, 606 West Wisconsin Ave., Milwaukee.

Jenkins Bros., Bridgeport, Conn., has elected C. C. Chamberlain, general sales manager, to a vice presidency of the firm.

American-Marietta Co., Chicago, has purchased the Charles R. Long, Jr., Co. of Louisville, Ky. Kenneth E. Clarke is president of the Long subsidiary and Walter C. Jeppson is vice president.

AHCO
DETERGENT
240
A NEW SYNTHETIC DETERGENT DERIVED FROM PETROLEUM


This product is for general use in detergent mixtures and is compatible with alkalies such as phosphates and carbonates

Efficient in hard water.

1% solution has a pH of 7.5 – 8.0.

Buff-colored, dry, non-hygroscopic compound, available in flake or powder form.

Packed in fiber drums holding 225-240 lbs.

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Manufacturing Chemists
ESTABLISHED 1815
Plants at Dighton, Mass. and Charlotte, N. C.
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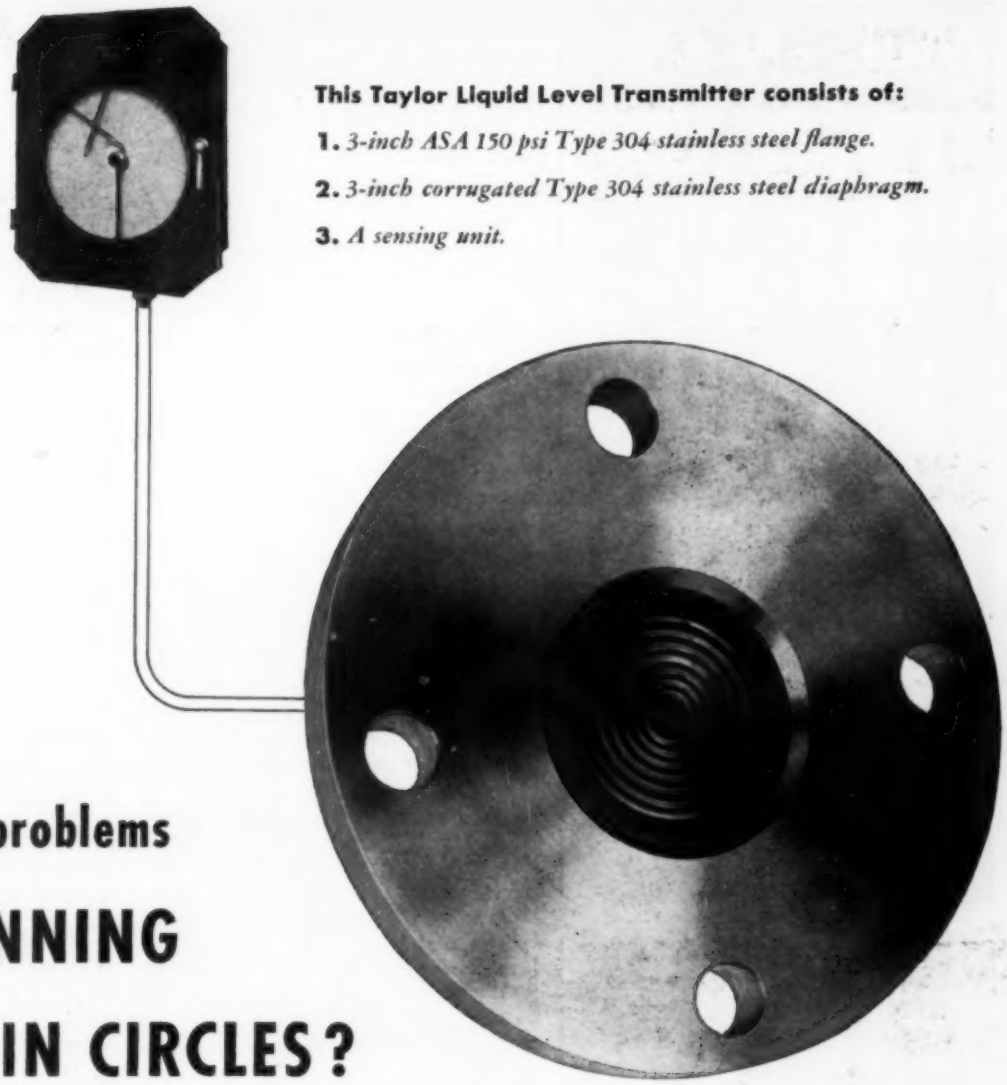

This Taylor Liquid Level Transmitter consists of:

1. *3-inch ASA 150 psi Type 304 stainless steel flange.*

2. *3-inch corrugated Type 304 stainless steel diaphragm.*

3. *A sensing unit.*

Liquid level problems got you RUNNING AROUND IN CIRCLES?

HERE'S a liquid level transmitter that will save you grief—because it can't clog up! The new Taylor 229R accurately measures the liquid level of slurries, soap, paper pulp, or any other viscous or corrosive liquids containing solids. It's a simple, highly responsive instrument built on the force-balance principle. Usable for liquid level ranges within the limits of 12 inches and 450 inches of water.

Here's how it works. The pressure of the head of liquid is exerted against the diaphragm attached to the flange and is balanced by an equivalent air pressure in back of the diaphragm. This back pressure is transmitted to a Taylor indicating, recording or controlling receiver which can be located anywhere you want it for a steadily dependable indication, record or control of liquid level.

For full details write for Bulletin 98069 or ask your Taylor Field Engineer. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording or controlling temperature, pressure, humidity, flow and liquid level.*

Taylor Instruments

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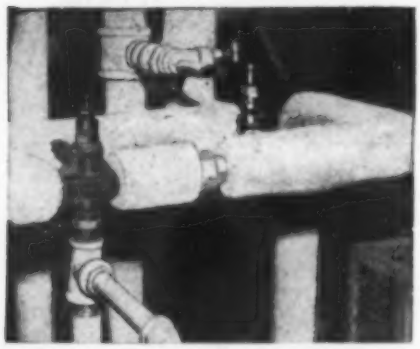

LOW COST COOLING CONTROLS

Few devices cost so little and save so much—because the Sarco TR-40 saves in many ways.

It saves water and increases engine efficiency by maintaining correct jacket temperatures. It saves lubricating oil—prolongs the life of the equipment. On condensers and stills it saves up to 50% of the water and insures dependable process operations. It boosts production on degreasers and other tank control processes. Sizes ⅜ to 1½ inch. Calibrated for any temperature between 40 and 200 degrees F. Bulletin 700. 198

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CONVENTION PAPER ABSTRACTS

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Manufacture and Uses of the Ethyl Silicates

THE esters of silicic acid were probably the first organic silicon compounds to achieve commercial importance. Monomeric ethyl silicate and its polymers are large tonnage industrial chemicals manufactured from silicon tetrachloride and ethanol by a continuous process which eliminates batch-to-batch variation.

All the important commercial applications hinge upon the ability of ethyl silicate to deposit silica from solution, so the techniques of hydrolysis and polymerization are of importance. Recent advances include the development of useful aqueous systems without mutual solvents, and the large tonnage availability of a stable liquid polymer with an equivalent SiO_2 content of 40 percent.

The ethyl silicates are used as adhesives for investments in precision casting, binders for other ceramics, gelling agents for alcohol fuels, sources of finely divided amorphous silica, building stone impregnants for weatherproofing, and in the preparation of glass adherent lacquers. Current research is directed toward the development of more flexible and more adherent heat-resistant surface coatings.

H. D. Cogan and C. A. Setterstrom, Mellon Institute of Industrial Research, before Division of Industrial and Engineering Chemistry, American Chemical Society, Atlantic City, April 15, 1947.

Southwest and West Are Entering Industrial Era

THE WEST and Southwest are entering an era of great industrial development. The people of these areas know that the processing of their natural resources yields greater wealth and a better standard of living. They have learned from the war that they have an abundance of skilled labor and an understanding of the techniques of manufacturing. In this development, the engineer and the scientist will play a major part. Never before has there been such a realization on the part of the people throughout the nation of the importance of technology to their future.

Synthetics will advance the industrial position of the Southwest. This part of the country is endowed with tremendous deposits of hydrocarbons in the form of natural gas, petroleum and coal, which together with other minerals and a broad variety of agricultural products give an almost complete source of supply for the production of synthetic materials of all kinds. We have already seen the growth of the chemical industry specifically in the states of Texas and Louisiana. These are based primarily on the utilization of natural gas but the process can be converted cheaply to the use of petroleum or coal as raw materials. These, therefore, are not temporary plants limited only to raw materials presently used, but with these alternate raw materials readily available in great quantities there is the assurance of a continuing and expanding industry.

Harold Vagtborg, Midwest Research Institute, before the American Society of Mechanical Engineers, Tulsa, Okla., March 4, 1947.

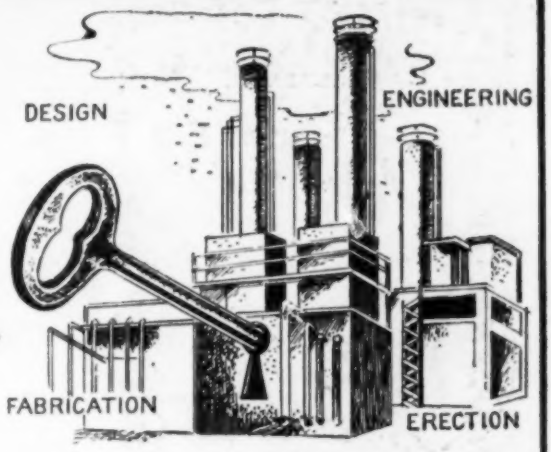
Chemical Industry of India

BEFORE the war, India produced about 70,000 tons of sulphuric acid whereas the consumption capacity was only 30,000 tons. Several new plants came into existence as a result of increasing demand by various war departments. The present production capacity of this industry is about 100,000 tons including the few plants which are under erection. It is feared that if other industries which consume sulphuric acid are not soon developed, there may be a surplus of this acid in India.

Largest amount of sulphuric acid is consumed in the manufacture of superphosphates which are used as fertilizers in all agriculturally developed countries. In India the fertilizer industry is yet in its infancy. If the government is contemplating manufacture of 400,000 tons of ammonium sulphate, it is necessary that arrangement be made for the manufacture of 600,000 tons of superphosphates in order to meet the agricultural requirements. The manufacture of 600,000 tons of superphosphates would involve large quantities of sulphuric acid and thus greatly assist the expansion of the sulphuric acid industry.

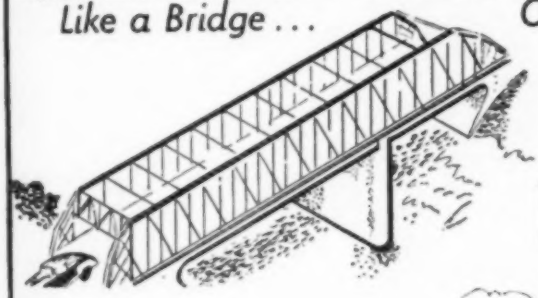
Among other chemicals developed during the war were magnesium chloride, bichromates, sodium thiosulphate, nitric and hydrochloric acid. Among alkalis, the production of caustic soda

Yes, We'll Do a Turnkey Job on Your Process Plant

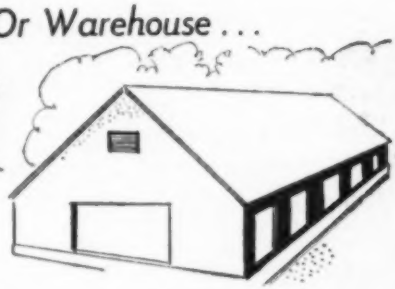


And We Won't Leave You At Sea On Other Needs

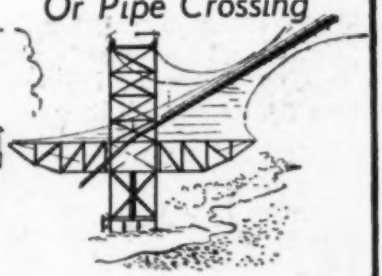
Like a Bridge . . .



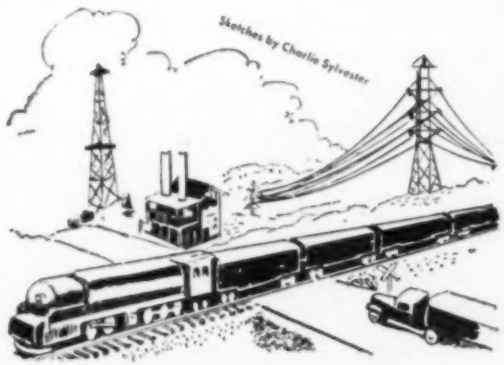
Or Warehouse . . .



Or Pipe Crossing



Or Anything Else You Can Mention We'll Build



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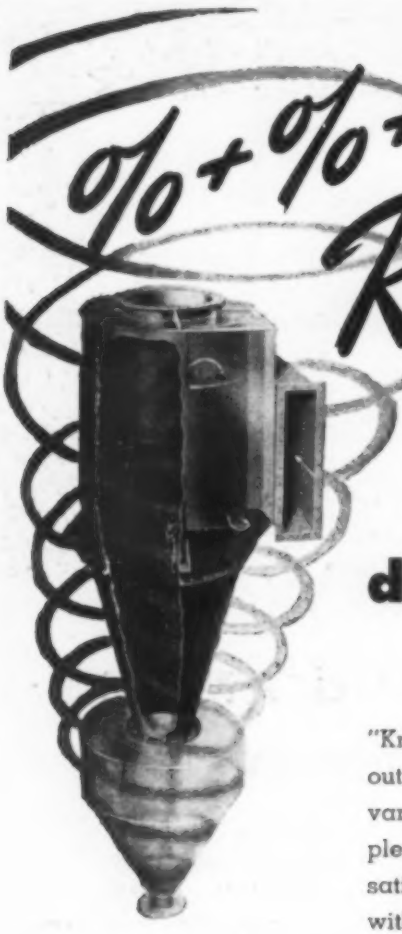

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the crux of dust separation

"Know Your Dust," says Buell. 999 times out of a thousand, the percentages of various micron sizes establish a complex separation problem. To anticipate satisfactory separation you must know with just what efficiency your collection apparatus will handle each of the different size particles present.

A Buell Fractional Efficiency curve will tell the complete story. Not a round-figure overall promise, but an analytical certification of performance on each of the sizes of your total dust.

Buell engineering can tailor equipment to your most exacting demands. And, instead of being complex, the layout will be relatively simple, the diameters relatively large — and draft demand and maintenance costs low.

The Shave off is the pay off—a van Tongeren System patented feature found only in Buell equipment. The how and why of it is graphically presented in a reference catalog every interested engineer should read. Write for "The van Tongeren System of Industrial Dust Recovery", Buell Engineering Co., 18 Cedar Street, New York 5, N. Y.

buell

Engineered Efficiency IN DUST RECOVERY

has also been started by a few firms. Soda ash is also being produced in India by two important concerns. There is, however, much more room for a number of plants for the production of caustic soda and soda ash. Manufacture of chlorine is also being done in India at several places but production is far from sufficient. Bleaching powder which was formerly an entirely foreign product is now manufactured at several places in India.

Some of the important primary chemicals, namely those which are needed in the manufacture of other chemicals and pharmaceuticals are not yet being made in India: chlorosulphonic acid, glacial acetic acid, acetic anhydride and some of the elements like sodium, magnesium and phosphorus. The entire range of organic and inorganic chemicals lies untouched. Some of the important products of the fermentation industry such as solvents like butyl alcohol, amyl alcohol and others like citric acid are not yet produced in India. The raw material for these is mainly molasses, an article which is in abundance.

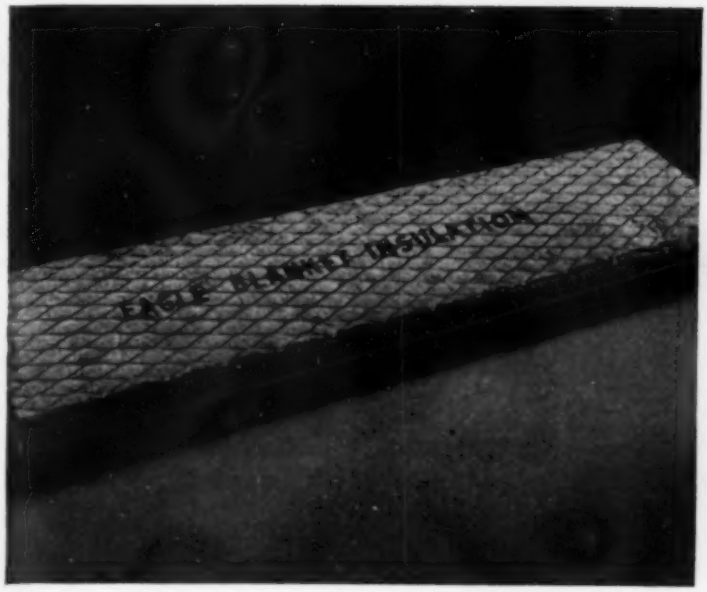
We have been hearing so much of planning of industries, of nationalization of industries and of economic planning that it becomes difficult to realize fully and clearly the nature of work which lies before us. It is true that the leaders of the country who hold the destinies of India in their hands are full of genuine desire to uplift the country. The people are longing for such uplift. The problem is how to achieve this aim.

K. A. Hamied, before the Indian Chemical Manufacturers Assn., Delhi, Nov. 21, 1946.

Calcium Carbonate Extender Pigments

ELECTRON microscopic photographs and light microscope photomicrographs have been taken of a series of calcium carbonate pigments. The results indicate average particle diameter from 3.9 to 0.05 microns and corresponding surface areas from 0.5 to 32 sq. m. per g. Chemical analysis indicates that all these pigments are essentially pure calcium carbonate. Likewise, X-ray diffraction patterns for all samples are similar except for the line broadening to be expected as a result of decreasing particle size. The differences in behavior of these materials may, therefore, be ascribed primarily to their differences in specific surface.

When used as extender pigments in a gloss enamel paint at loadings from 4 to 20 percent based on the total pigment content, consistency of the paint was found to increase with the surface area of the extender pigment.



Temperature control demands

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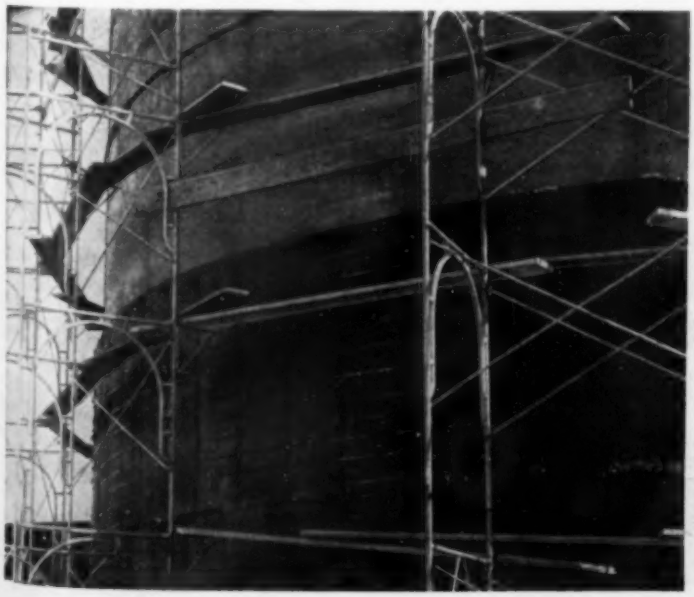
Eagle-Picher Mineral Wool Blankets

give permanent heat-saving performance

Long service on heated equipment does not lower the high insulating efficiency of Eagle-Picher Blankets. Their principal ingredient, Eagle-Picher Mineral Wool, does not break down or deteriorate despite continuous exposure to temperatures as high as 1200 F. This physical and chemical stability enables Eagle-Picher Blankets to permanently resist water, steam, moisture, corrosive fumes and normal vibration. Complete technical and application data sent on request.

The complete line of Eagle-Picher Insulations includes:

Eagle-Picher Super "66" Cement
Eagle-Picher Supertemp Block
Eagle-Picher Low Temperature Felts
Eagle-Picher Loose Wool
Eagle-Picher Stalastic
Eagle-Picher Insulseal
Eagle-Picher Pipe Covering
Eagle-Picher Insulstic
Eagle-Picher Swetchek
Eagle-Picher Finishing Cements



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A FLARE FOR PROTECTION . . . Side wings on this metal-edged, easy-to-wear Protecto-Shield* give extra protection . . . deflects splashing liquids from face, head and eyes.

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Likewise, there appears to be a tendency for hiding power to increase with surface area.

The increase of consistency is related to decrease in plasticity and increase in modulus found when this same series of materials was milled in rubber. All three products should depend on (1) volume loading and (2) shape of suspended particles. The effect of surface area appears best explained by the fact that the amount of vehicle adsorbed and immobilized at the particle surface increases with specific area, causing an apparent increase in volume loading of the dispersed phase.

A possible explanation for the increase in hiding power may be the effect of the extender pigment of dispersion of the hiding pigment. This effect may be assumed to increase with decreasing particle size of extender pigment. In this connection it was found that certain extremely fine particle size calcium carbonate pigments can, under proper conditions, increase the depth of color of a tinted enamel. This, likewise, appears to be due to improvement in dispersion of the tinting pigment when the latter is ground with fine particle extender pigment.

L. H. Cohan and H. W. Siesholtz, Witco Technical Service Laboratory, before Division of Colloid Chemistry, American Chemical Society, Atlantic City, April 16, 1947.

Company Policies and Public Relations

A PRODUCT has to meet three prime requirements: it has to be available in quantity; it must be of high quality; and it must sell at a price all can afford. A lot of people don't believe that our American system does this. They believe a state-controlled industry would produce more, better and cheaper.

You can't expect people to accept and appreciate a situation or system about which they know little or nothing. A well and accurately informed American public can be expected to act intelligently. Given the honest facts, the public will reach a logical conclusion.

A lot of able men in management think that by hiring the man and allocating the money, they automatically have good "public relations." Business will go all out to tell the public about a new product that has been discovered. Yet, when it comes to the important job of telling what made those products possible and what American productivity means to the nation, the majority of top management just won't act.

In too many cases, the relationship a company enjoys with the public is a minor matter to management. However, even this is shortsighted. Under

When it comes to better, faster, lower cost mixing of thermoplastic powders, you can't beat the Simpson method of *controlled* "mulling," to provide the desired impregnation of plasticizers and fillers into the resins.

Simpson Mixers are available in sizes to handle batches from 1/5th to 50 cu. ft., and may be steam or water jacketed to provide heat for more rapid blending of plasticizers. All models are virtually self-cleaning, and offer the well-known automatic discharge feature.

Write for further details about Simpson Mixers now in use on scores of difficult mixing jobs on dry, semi-dry and plastic materials. National Engineering Service is yours for the asking.

SIMPSON *Intensive Mixers*

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Manufacturers and Selling Agents for Continental European Countries — The George Fischer Steel & Iron Works, Schaffhausen, Switzerland. For the British Possessions, Excluding Canada and Australia — August's Limited, Halifax, England. For Canada — Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand — Gibson, Battle & Co., Pty., Ltd., Sydney, Australia

WHY PUSH WHEN YOU CAN CONVEY

Pushing material around is not only slow, hard work — it's costly material handling — there's an easy way to do it.

Investigate the use of conveyors. Conveyors handle a wide variety of parts, packages, units, cans, bottles, barrels, bundles, drums and boxes. Available in light, medium or heavy-duty types — portable or stationary — as systems, sections or units — power or gravity fed, they give you remarkable savings in time, money and manpower conservation. They relieve confusion and congestion.

Standard Conveyor Company has the experience and facilities to engineer, recommend and furnish the right type of conveyor for your particular needs.

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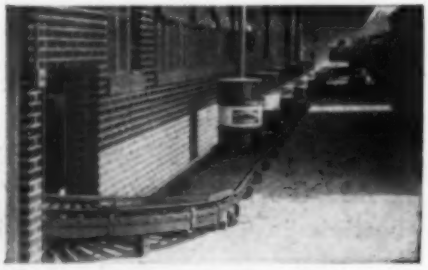
PRODUCTION LINES
Slat type conveyor used to speed assembly and crating of refrigerators.

STORAGE AREAS
Portable "Handibilt" conveyors used as a continuous conveyor line in storage area.



LOADING PLATFORM
Oil drums leave the warehouse for loading into boxcars on gravity roller system.

ROLLER · BELT · SLAT · PUSHBAR CONVEYORS • PORTABLE CONVEYORS AND PILERS • SPIRAL CHUTES • PNEUMATIC TUBE SYSTEMS

our competitive system a lack of public approval will ultimately show in red on the balance sheet.

The person responsible for public relations in any company has to be close to the top management of that company. He has to be taken into management's confidence because, above all else, he must know what goes on in the company before he can do an intelligent job of reporting.

Along with a lot of other subjects, profits must be taken out of the "secret" class if the public is to understand the American corporate system. The public is perfectly justified in asking what management has to hide in the maze of figures surrounding, and often obscuring, what could be a simple explanation of corporate financial statements.

Does management have anything to hide? The contributions that a company makes to the community or nation, the reasons why the company is in business, how it distributes monies received and, all in all, pretty much everything management does, should be able to stand the careful scrutiny of the public. If a policy isn't going to stand careful scrutiny by the public, it isn't a good one. No amount of talking is going to sell the people on policies and programs that are contrary to public interest. You have got to have a factual and honest story and then tell it.

Company employees are a part of the public. Do they know what the company contributes to the general economy? Do they know what percentage of income goes to wages and what is classed as profit? Do they understand that when capital has an incentive to invest more per employee that this helps to raise the employee's standard of living, shorten his working hours and improve working conditions? Employees are potentially the greatest selling force American industry has, but, like a lot of other people, they have not been accurately informed.

Consider the company's shareholders. Do they take an interest in the company beyond their dividend checks? It is good public relations to see that they do. For here again, they can be close to the company and as such, be vocal supporters of not only the company, but the system that makes it possible.

Do you ever think of your customers beyond the point where they sign the dotted line? They have a real and personal interest in the economic system that provides them with the necessities of life. A customer has the right to know that this system of ours provides the best. If in addition to buying the product, they like the company and the way of life that al-

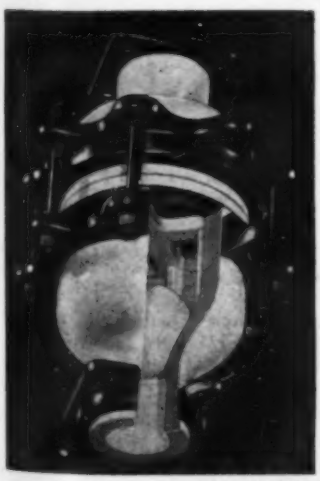
PORCELAIN IS A *Natural* CHEMICAL HANDLING MATERIAL

ILLINOIS PORCELAIN VALVES

ALL ILLINOIS Valves are very carefully designed to give maximum uninterrupted service life under normal operating conditions. The valve seat is located in the lowest possible position so that you get uninterrupted flow of material when stem is in open position. Packing is acid-resisting asbestos—graphite impregnated. The ends of valves are ground parallel for gasketing. All valves are tested 100 lbs. hydraulic pressure.

PIPE AND FITTINGS

ILLINOIS high quality porcelain pipe and fittings are very accurately cut to length. Ends are ground absolutely smooth for gasketing. Flanges are assembled so that the bolt holes are in line. The flange faces are parallel to the ends. The inside and outside is glazed white. The porcelain fittings used with pipe are ground at right angles and to exact dimensions. Installation is fast and simple.



CHECK VALVES

Ends are ground parallel for gasketing. Ball is ground and polished to exact sphere and the ball seat is ground and polished for perfect fit to completely shut off leakage past the ball. The guides for centering the ball are carefully ground to close tolerances. Liquid space around ball is ample to allow free flow.

Diaphragm limits rise of ball, preventing knocking. The perforations in the diaphragm are slightly greater than the inside area of the pipe. These vertical check valves can be installed in the line or as a foot valve.

Angle check valves are also available.

★Porcelain is a natural chemical-handling material because it does not deteriorate or corrode and electrolysis cannot take place—corrosion usually is the result of electrolysis and when high grade porcelain is used there can be no corrosion.

Send for Catalog No. C-1

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ILLINOIS ELECTRIC PORCELAIN CO. *Macomb, Illinois*

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has been purifying a wide variety of lubricating, fuel, and industrial oils

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★ **COMPRESSORS** – kept free from carbon and varnish deposits.

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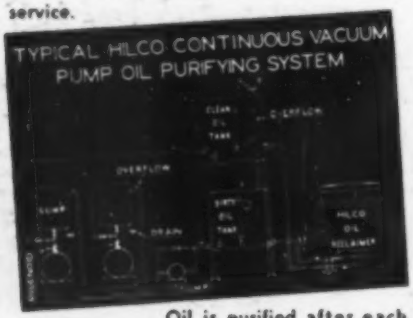

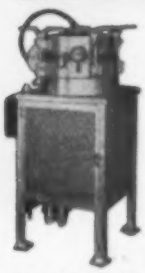

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We can go right down the list — supplies, other corporations in the same industry, dealers, transporters, and so on. Beyond that lies the great mass of American people who are probably uninterested in your individual company, but who are aware of your industry and the American economic system.

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Reese H. Taylor, Union Oil Co., before American Council of Public Relations, San Francisco, Calif., Feb. 18, 1947.

Atomic Power From Shale Oil

NEW sources of uranium have been opened through the development of a large shale oil industry in Sweden to offset coal and petroleum shortages.

Uranium oxide, the compound used in generating atomic energy, is one of several byproducts obtained in producing oil from shale, which is a type of rock formed by the hardening of clay, mud or silt and which is found in great abundance in Sweden.

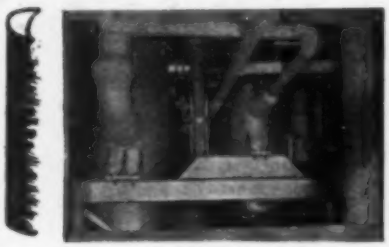
The shale is radioactive and contains about 220 g. or nearly a half pound, of uranium oxide per ton, as well as aluminum, vanadium and molybdenum. The Swedish government, which is operating the shale oil project, is seeking profitable uses for all byproducts in an effort to make the program self-sustaining.

Gustav Egloff, Universal Oil Products Co., before Chicago Section, American Chemical Society, Evanston, Ill., Jan. 24, 1947.

A Hydrogenation Catalyst—Vanadium Oxide

OLEFINIC hydrocarbons when subjected to the action of vanadium oxide-aluminum oxide catalyst at 400 deg. C. and atmospheric pressure were converted to the corresponding paraffinic hydrocarbons with approximately quantitative yields. Diolefins were also readily hydrogenated to saturated hydrocarbons under the same reaction conditions. No olefins were detected in the reaction product.

Attempts to hydrogenate benzene with vanadium oxide have been unsuccessful to date at both atmospheric



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While the steam jet vacuum equipment is not suitable for the extremely low pressures obtained with diffusion pumps, it has been developed to the point where it overlaps the applications of this equipment, particularly at pressures above 100 microns. From this pressure through all the intermediate range of vacuum up to atmospheric pressure, Croll-Reynolds EVACTORS are handling a great variety of industrial requirements, and frequently helping to pioneer new industrial processes. Inquiries are solicited on this equipment, also on all types of steam condensers, and on the Croll-Reynolds CHILL-VACTOR unit for flash cooling of water and aqueous solutions.

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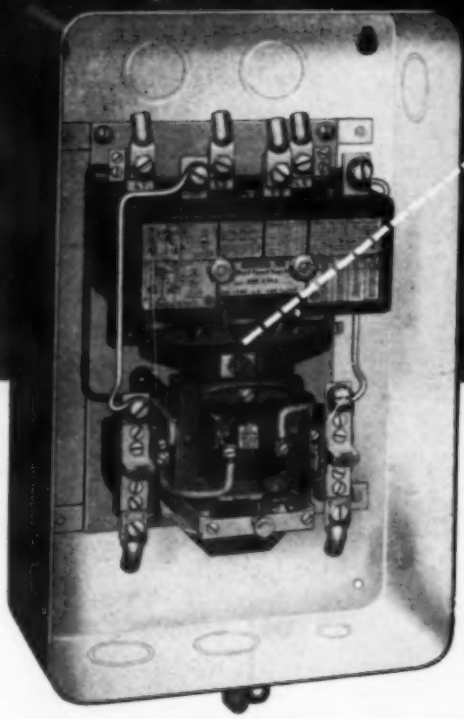

BULLETIN 709

Size 2, Bulletin 709, across-the-line solenoid starter with cover removed. The white interior reflects light and illuminates the starter in dark corners. Note how the generous space and the position of the terminals make wiring easy.

Because

ONLY ONE MOVING PART

No pins—No pivots—No hinges—
No bearings to cause trouble

Moving parts are the trouble-makers in any mechanism. The only moving part in the Allen-Bradley solenoid starter is the single solenoid plunger which carries all the movable contacts.

The Allen-Bradley solenoid starter is so trouble-free because there are so few parts, and the double break, silver alloy contacts never need filing, cleaning, or dressing. With Allen-Bradley solenoid starters on your textile machinery you can get millions of trouble-free operations. Just install this starter...and forget it! Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.

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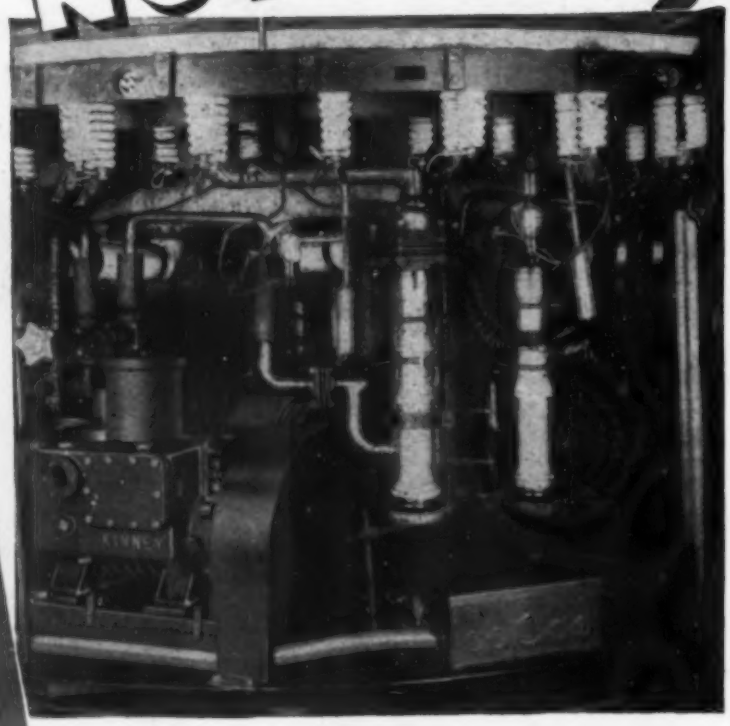

Compact installation of Kinney Compound High Vacuum Pumps used to back diffusion pumps in the manufacture of ultra high frequency tubes at Raytheon Mfg. Co., Waltham, Mass.

IN A SMALL SPACE

The compact design of Kinney High Vacuum Pumps enables them to be grouped closely with auxiliary equipment . . . shortens pipe lines . . . saves valuable floor space. Kinney Pumps are self-contained units, easily installed. Having automatic lubrication and oil sealing, they produce high vacuums indefinitely with minimum attention.

The faster pump down and lower ultimate pressures of Kinney High Vacuum Pumps shorten production time and cut costs in vacuum processing—exhausting lamps and tubes, sintering alloy metals, coating lenses, producing drugs, etc. Kinney Single Stage Vacuum Pumps produce low absolute pressures to 10 microns; Compound Pumps to 0.5 micron.

Write for Bulletin V-45.

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KINNEY HIGH VACUUM PUMPS

and high pressure (21 to 5 atm.) conditions.

The space velocity proved to be a critical variable for the hydrogenation reaction; a value of 0.050 liquid space velocity was found to be the maximum without serious loss of efficiency.

V. I. Komarewsky, L. B. Bos and J. R. Coley, before Division of Petroleum Chemistry, American Chemical Society, Atlantic City, April 18, 1947.

FOREIGN LITERATURE ABSTRACTS

Silicones for Electrical Construction

STARTING with $SiCl_4$, the classical Grignard reaction gives alkyl-silicon chlorides which are hydrolyzed and then polymerized with heat. The viscosity of silicones increases with the number of organic radicals combined with the 1 atom of Si. The fully condensed products which can be used as such are in the form of liquids (for transformers, brakes, lubricants), greases with low vapor tensions for valves, compounds (for stopping spark plugs of motors), films (condensers, insulation of coils). The incompletely condensed products which must be boiled before using are electrotechnical varnishes adhering at 200 deg. and used to impregnate glass and asbestos fabrics, resins for insulation of conductors, plastics and insulating silicones. These products, which are of interest in all fields of electrical engineering, are incompatible with the usual organic insulators. Their disadvantages are the present difficulty of supply, their price (7-18 dollars per kg.) and the need for using ovens attaining 200 deg. Their advantages are resistance to reagents, water, raised temperatures, excellent resisfivity and specific inducing capacity, good mechanical qualities of varnishes and insulators, absence of aging, no decomposition, no physiological action.

Digest from "The Silicones. Their Utilization in Electrical Construction" by G. de Semarclens, *Bull. Assoc. Suisse Electr.* 37, No. 5, 117-126, 1946; *Chimie et Industrie* 57, No. 2, 159, 1947. (Published in France.)

Suspending Capacity of Boring Solutions

WASHING solutions used in boring were investigated to determine the suspending capacity of such clay suspensions in relation to the concentration of foreign particles (sand) and to time. It was found that the absolute quantity of sand retainable by

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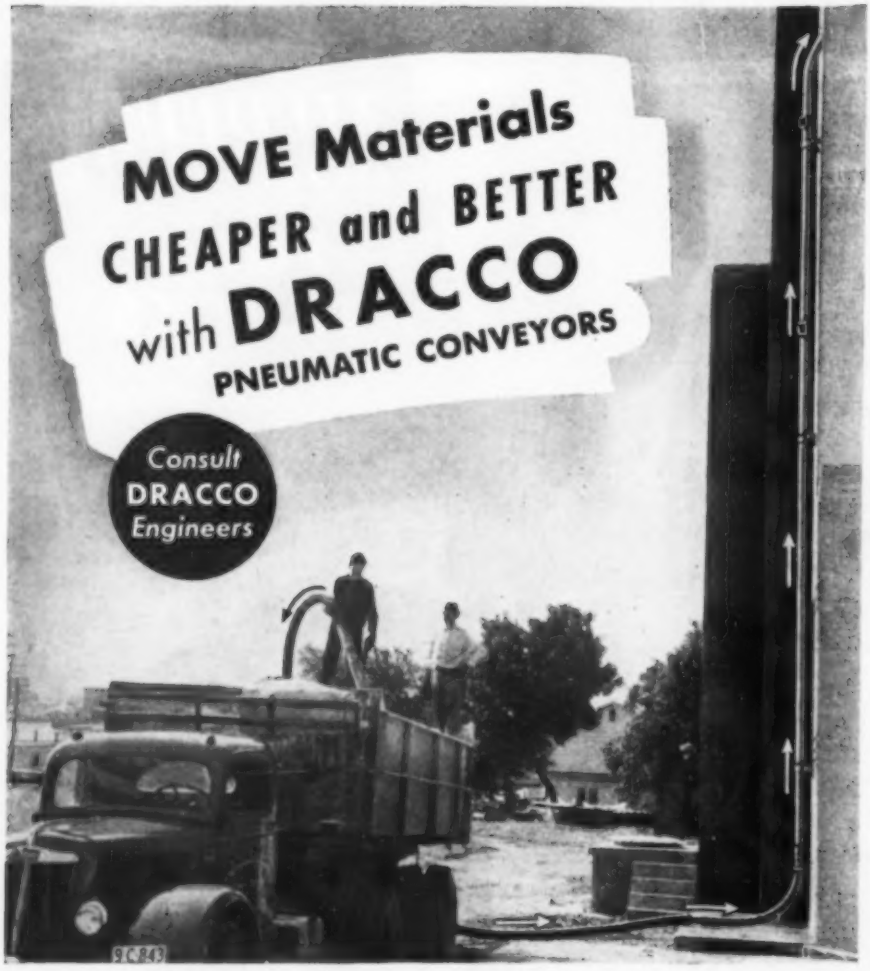

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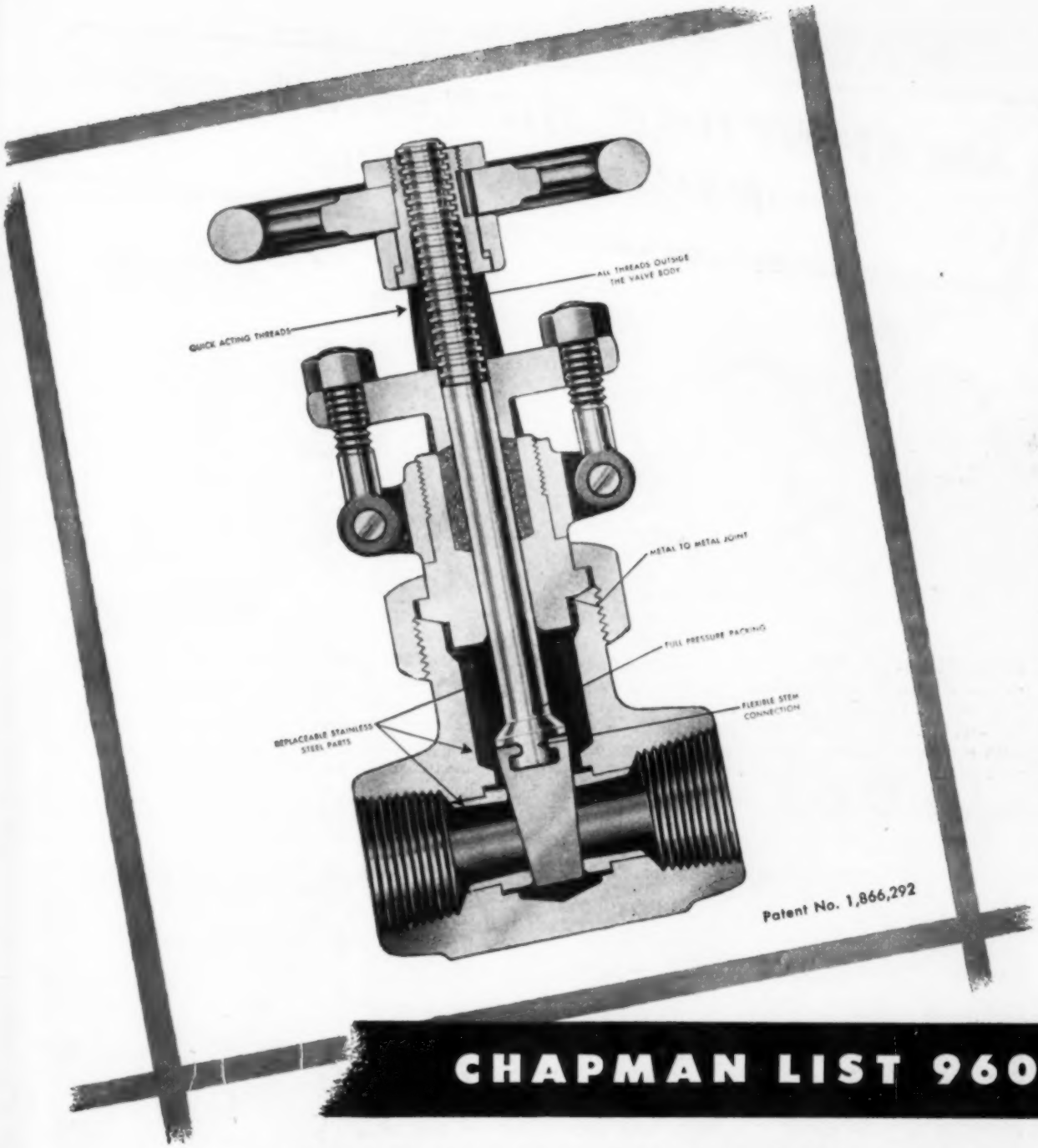
suspensions increases with increase in its concentration. Relative quantity of sand held in suspension changes with its concentration, depending on the size of the particles of sand and on the concentration of clay in the suspension. The absolute quantity of sand settling out increases with increase in the initial concentration of sand in the suspension. The sand precipitates out of the clay suspensions mostly at the beginning of the settling. An increase in the time of standing of the suspension with sand, above 1 hr., does not have a noticeable effect on the quantity retained. These results are explained by the changes in the development of the structure of the clay suspensions with time and by the effect of concentration and dispersion of the suspended particles on the formation of structures.

Digest from "Suspending Capacity of Washing (Clay) Solutions used in Boring" by P. M. Khomikovski and D. I. Shilov, *Zhurnal Prikladnoi Khimii* XIX, No. 8, 841-847, 1946. (Published in Russia.)

Ethoxy Derivatives of Divinylacetylene

DIVINYLACETYLENE was ethoxylated with either sodium ethylate or an alcohol solution of KOH serving as catalyst. On oxidizing the resulting product with $KMnO_4$ the following compounds were separated out: formic, acetic and ethoxyacetic acids. This shows that the ethoxy derivative of divinylacetylene has the structure of 1-ethoxy-hexatriene-2, 3, 4. Chlorination yielded products of the addition of 2 and 4 chlorine atoms. The physical constants and the composition of the di-1-ethoxy- hexatriene-2, 3, 4 and tetrachloride was determined. The ethoxy derivatives of the divinylacetylene are very different from the latter both in their rate of polymerization and in the properties of their polymers. Their rate of polymerization is lower and their polymers, obtained with or without a catalyst, are oily liquids, soluble in organic solvents, which dry slowly and form an elastic film. Ethoxy derivatives of divinylacetylene can undoubtedly find application in the manufacture of valuable lacquers. They have the advantage over divinylacetylene in that they are very stable to the action of air. On storage for a year or more at room temperature, there is almost no change in their appearance and coefficient of refraction. In addition, their synthesis is very simple and the yields (50-60 percent) are fairly good and could be improved.

Digest from "Alkoxy Derivatives of Divinylacetylene. III" by A. L. Klebanskii, D. M. Krasinskaya and L. G. Saphonova, *Zhurnal Obshchei Khimii* XVI, No. 8, 1213-1230, 1916. (Published in Russia.)



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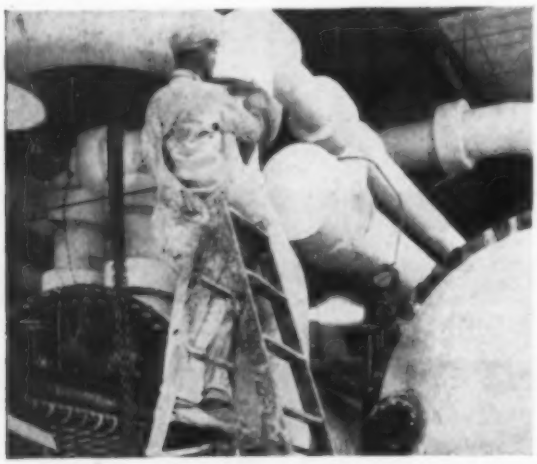

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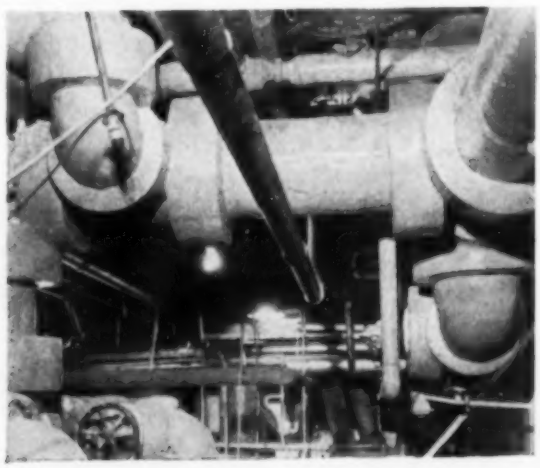

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CHEMICAL ENGINEER'S BOOKSHELF

Lester B. Pope, ASSISTANT EDITOR

A Model Report

GERMAN PLASTICS PRACTICE. *By John M. DeBell, William C. Goggin and Walter E. Gloor. Published with permission of the U. S. Department of Commerce, by DeBell and Richardson, Springfield, Mass.* 554 pages. $7.50.

Reviewed by S. D. Kirkpatrick

LITERALLY tons of manuscripts, documents and reports on German chemical industries have been prepared by the many hundreds of American and British investigators who have spent more than two years in visiting enemy plants and laboratories and interviewing scientists and engineers. The greatest shortcoming of this huge literature is that most of it was hastily prepared and has never been adequately correlated and interpreted. This volume, first prepared by recognized American authorities in the plastics industry for the Quartermaster General, is a welcome exception among the technical reports to come out of Germany since V-E Day.

It is comprehensive, well organized and fully illustrated with plant photographs, diagrams and flowsheets. There are 26 chapters, a useful 10 page glossary of German trade names and 22 pages of subject and name indexes.

Twenty outstanding technical advances in the German plastics industry which are discussed in considerable detail include the following: (1) Caprolactam as a new synthetic fiber and sheet material. (2) Chlorinated polyvinyl chloride for rot-resistant fabrics. (3) Carboxymethylcellulose to extend soap. (4) Magnetic iron oxide filler for recording tape and anti-radar applications. (5) Vinyl chloride paste castings for shoe soles and coatings. (6) Isocyanates for synthetic polyamide type of fibers and high melting thermoplastics. (7) Phenolic can lacquers and acrylic-vinyl sealing compounds. (8) Foams, not only conventional but with new foam agents. (9) Polyamide films, cast and stretched. (10) Improved rubber latex and short rubber polymerization. (11) Unplasticized flexible polyvinyl chloride in 0.001-in. films. (12) Fungus resistant systems. (13) Magnetic molded materials for mines and fuses. (14) Lead cyanamide pigment to reduce corrosion. (15) Oriented thin polystyrene sheet. (16) Astralon transparent rigid sheets, vinyl chloride acrylate or malcate copolymer. (17) Acetylene and CO derivatives for blood transfusion, new solvents, glycerine substitutes, etc. (18) Non-oil protective coatings. (19) Polyvinyl alcohol for body cavity filling. (20) Reppe chemistry, particularly (a) vinylation (b) ethynylation and (c) carboxylation.

As evident from abundant references and credit acknowledgments, this book represents the work of many American and British investigators, but it is not a hodge-podge of unrelated material. Its real value lies in the fact that the authors have confined themselves to the most recent developments and have presented them in interesting, readable fashion.

Elementary

THE ELECTRONIC THEORY OF ACIDS AND BASES. *By W. F. Luder and Saverio Zuffanti. John Wiley & Sons, New York.* 164 pages. $3.

Reviewed by G. F. Kinney

HERE is an elementary presentation of a too frequently neglected theory of modern chemistry, the electronic theory of acids and bases first proposed by G. N. Lewis in 1923. A recast of the original theory in view of more precise knowledge of atomic orbitals and the nature of valence serves to emphasize its fundamental correctness.

The nature of acids and bases has been a subject of speculation for centuries, involving such famous names as Boyle, Lavoisier, Davy, Berzelius, Arrhenius, and now Lewis. Lewis arrived at his electronic suggestion by reconsidering experimental facts, first defining an acid by "phenomenological criteria" of neutralization, effect on indicators, displacement, and catalytic effects. He concluded that an acid is a material which can accept a pair of electrons to form a coordinate covalent bond, that a base is the donor of the electron pair, and that neutralization is the formation of the bond.

The major portion of the book is devoted to acid-base nature of specific compounds covering a wide field of interest and interpreted in terms of electronic structure, but with the unfortunate omission of compounds of interest to the mineralogist or metallurgist. Most of the material has been published previously, notably in the *Journal of Chemical Education*.

RECENT BOOKS RECEIVED

Calculations of Analytical Chemistry. 4th ed. By L. F. Hamilton & S. G. Simpson. McGraw-Hill. $3.50.

The Chemistry of Portland Cement. By R. H. Bogue. Reinhold. $10.

Marketing Drugs and Cosmetics. By L. Bader & S. Picker. Van Nostrand. $5.

A New Notation and Enumeration System for Organic Compounds. By G. M. Dyson. Longmans, Green. $1.75.

The Problem of Reducing Vulnerability to Atomic Bombs. By A. J. Coale. Princeton University Press. $2.

The Rare Earth Elements and Their Compounds. By D. M. Yost, H. Russell, Jr., & C. S. Garner. Wiley. $2.50.

Technological and Physical Investigations on Natural and Synthetic Rubbers. By A. J. Wildschut. Elsevier. $3.

Tungsten. 2nd edition. By K. C. Li & Chung Yu Wang. Reinhold. $8.50.

The Wet Purification of Coal Gas and Similar Gases by the Staatsmijnen-Otto-Process. By H. A. J. Pieters & D. W. van Krevelan. Elsevier. $1.25.

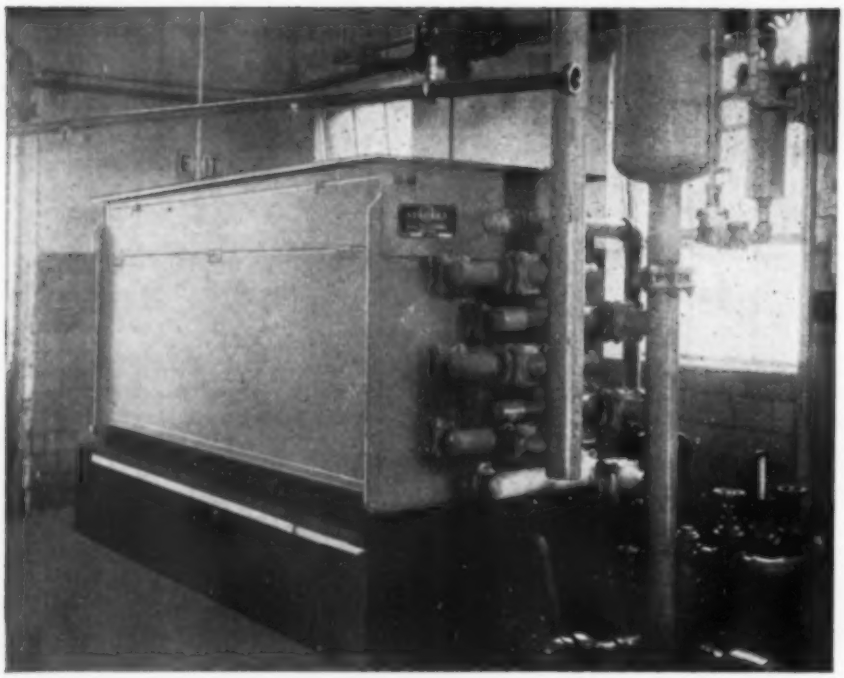
New Developments

TECHNOLOGY OF ADHESIVES. *By John Delmonte. Reinhold Publishing Corp., New York.* 502 pages. $8.

Reviewed by James A. Lee

THERE has been a need for some time for a book dealing with the new developments in adhesives. The synthetic resins have revolutionized the industry which for generations had thought and worked only with such materials as fish and animal glues. Tremendous strides have been made in the field by the urea and melamine resins, the phenolics, and many of the other synthetic resins. These new adhesives have in turn greatly changed the plywood and other industries.

Much has been written about these developments in numerous magazine articles, in patents and elsewhere in the literature. This material has been gathered together by the author and has served as background for his book. He makes direct quotations from these articles and gives a very long list of



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Write for Bulletin No. 100-CM

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literature references at the end of each chapter. To the previously published information he has added his own knowledge gained from some years in the field of resins.

As should be done in such a case, Mr. Delmonte treats first the thermosetting resins such as phenolics, ureas and melamines; next the polyvinyl, polystyrene, acrylic and other thermoplastic synthetics. Adhesives from cellulose derivatives, protein substances follow; and finally vegetable, animal and sodium silicate adhesives are treated.

After covering the various types of adhesives the author deals with theories of adhesive action, and adhesives for different types of materials: Wood, metal and rubber, tapes, paper, cloth and foils.

Reference

PLASTICS HANDBOOK FOR PRODUCT ENGINEERS. *Compiled and edited by John Sasso. McGraw-Hill Book Co., New York.* 468 pages. $6.

Reviewed by Myron A. Coler

THIS volume is intended to supplement the standard references already available in the field and to take cognizance of new developments by presenting "in concise handbook form, practical and fundamental data of specific use to the engineer planning to adopt these new materials to new product designs." It is a compact, clear and readable compilation which should prove most helpful to those who have had limited experience in the plastic field. It will also provide convenient reference and check-list information for those who have had extensive experience.

The book is divided into three major parts dealing with Plastic Materials, Design of Plastic Products and Rubberlike Materials respectively. The Appendix provides a brief bibliography and reference lists of trade catalogs tabulated by companies and by materials. An appreciable portion of the text has been taken from articles which appeared in *Product Engineering* under the editorship of Mr. Sasso. Paul O. Powers has prepared the introductory chapters for Parts I and III surveying the chemistry of the principal plastics and synthetic rubberlike materials; flowsheets are included.

Part I, Plastic Materials, comprises two-thirds of the volume. The chapter on chemistry of plastics is followed by an extensive chapter of 183 pages which summarizes representative data on the properties of the principal plastic materials. The quantitative data are presented compactly by means of over 50 well annotated tables and over 60

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AN OPEN LETTER TO NERO WOLFE, DETECTIVE, GOURMET, AND ORCHIDIST

Mr. Nero Wolfe
c/o AMERICAN MAGAZINE
New York, New York

Dear Mr. Wolfe:

In a recent report on your activities, chronicled by your estimable assistant, Mr. Archie Goodwin, under the title "Before I Die", you are recorded as having been approached by a character involved in sundry black market operations. Mr. Goodwin further states that you asked this character to obtain for you some "stainless steel ... bolts and nuts ... rivets".

We admire your perspicacity in realizing the superiority of stainless steel products, just as we admire your investigatory abilities. But, while we are fully aware that you were only testing the capacity of this character, we think you should know that no one has to resort to illegalities when searching for stainless steel bolts, nuts, rivets, or other fastening devices. Our stock room is full of them, in all shapes and sizes, and we'll be glad to provide all you need.

We'll be delighted to send you, or anyone else, a copy of our catalog and our current stocklist, on request. Or, if your needs are for some special analysis or specification, we'll be glad to manufacture the fastenings you wish, in a very short time.

We've been making stainless steel fastenings for twenty years, and we think that our reputation, in our particular field, compares favorably with yours in the field of detection.

Sincerely,

Richard Mack
Treasurer
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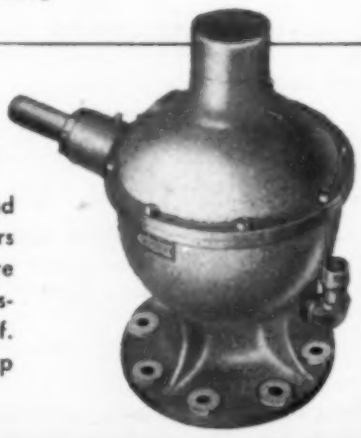

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graphs. Helpful prefatory and interpretive remarks are incorporated. The information contained in this chapter is substantially that provided by the Plastics Materials Manufacturers' Association.

The remaining chapters of Part I review concisely the familiar processing and fabricating techniques and include sections on machining and finishing operations. More recent developments in materials and processing techniques such as electronic preheating of shock-resistant materials, low pressure laminating and vacuum forming are highlighted.

Part II, Design of Plastic Products discusses the selection of materials and mechanical factors to be considered in designing for appearance, economy and optimum structural characteristics. Major plastics are classified according to properties—structural, electrical, thermal and chemical. Tables covering common faults, causes and remedies in the compression molding of phenolics, ureas, cellulose acetates and vinyls and the injection molding of cellulose acetates, polystyrenes and vinyls are included.

Part III, Rubberlike Materials, supplements the rest of the volume by providing in abbreviated form a discussion of synthetic rubbers which parallels the treatment accorded the conventional plastic materials.

There are several slips and weak spots, e.g., Fig. 51—ordinates for notched Izod impact strength are high by a factor of ten, p. 323—specific resistance of copper is based on a cross-section of 1 sq.cm. not 1 sq.in. The index is skimpy; since the volume is designed to serve as a handbook, the reviewer feels that its usefulness would be appreciably enhanced by the inclusion of a more complete index. The format is good. There are numerous carefully selected illustrations.

Organic Reference

ENCYCLOPEDIA OF HYDROCARBON COMPOUNDS: C_1 TO C_5. *Compiled by Joseph E. Faraday. Chemical Publishing Co., Brooklyn.* $15.

WHAT Beilstein and Richter have done for all organic compounds in the past, this book proposes to do for the organic compounds having from one to five carbon atoms. The information is complete up to Jan. 1, 1944. It details the occurrence, methods of preparation, physical constants and a solvent for recrystallization for each compound. The encyclopedia has a loose-leaf arrangement which will allow regular supplements to be inserted in their proper places. Richter's formula index system has been used.

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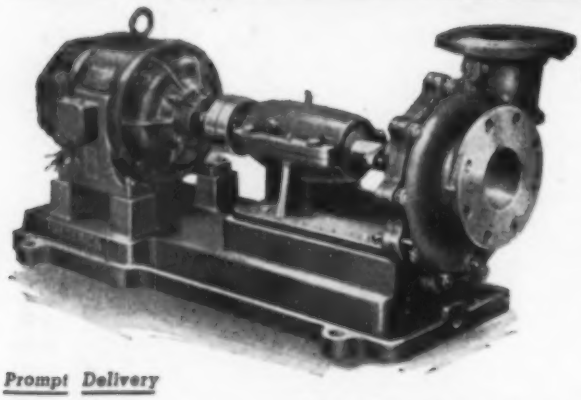

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First Industrial Directory of Mexico, 1947-1948 edition. Rolland Publications, S. de R. L. Plaza de la Republica No. 6—407 Mexico, D. F. 1,024 pages. $20. Lists all Mexican industrial companies, their addresses, name of managers, raw materials used, products manufactured and capitalization.

The Corrosion of Feed Screws of Small Underfed Stokers. By R. A. Sherman, J. F. Foster and D. A. Hinckle. Published by Bituminous Coal Research, Inc., 912 Oliver Bldg., Pittsburgh 22, Pa. 23 pages. 25 cents. Results of an investigation at Battelle Memorial Institute sponsored by Bituminous Coal Research and the Calcium Chloride Association.

Fire and Explosion Hazards of the Manufacture of Synthetic Rubber. N.B.F.U. Research Report No. 4, available from National Board of Fire Underwriters, New York, Chicago and San Francisco. 31 pages. A concise description of synthetic rubber manufacture with recommended safeguards for all hazardous locations and operations.

Survey and Directory of Marketing Research Agencies. By Ernest S. Bradford. Published by Bureau of Business Research, City College School of Business, 17 Lexington Ave., New York, N. Y.

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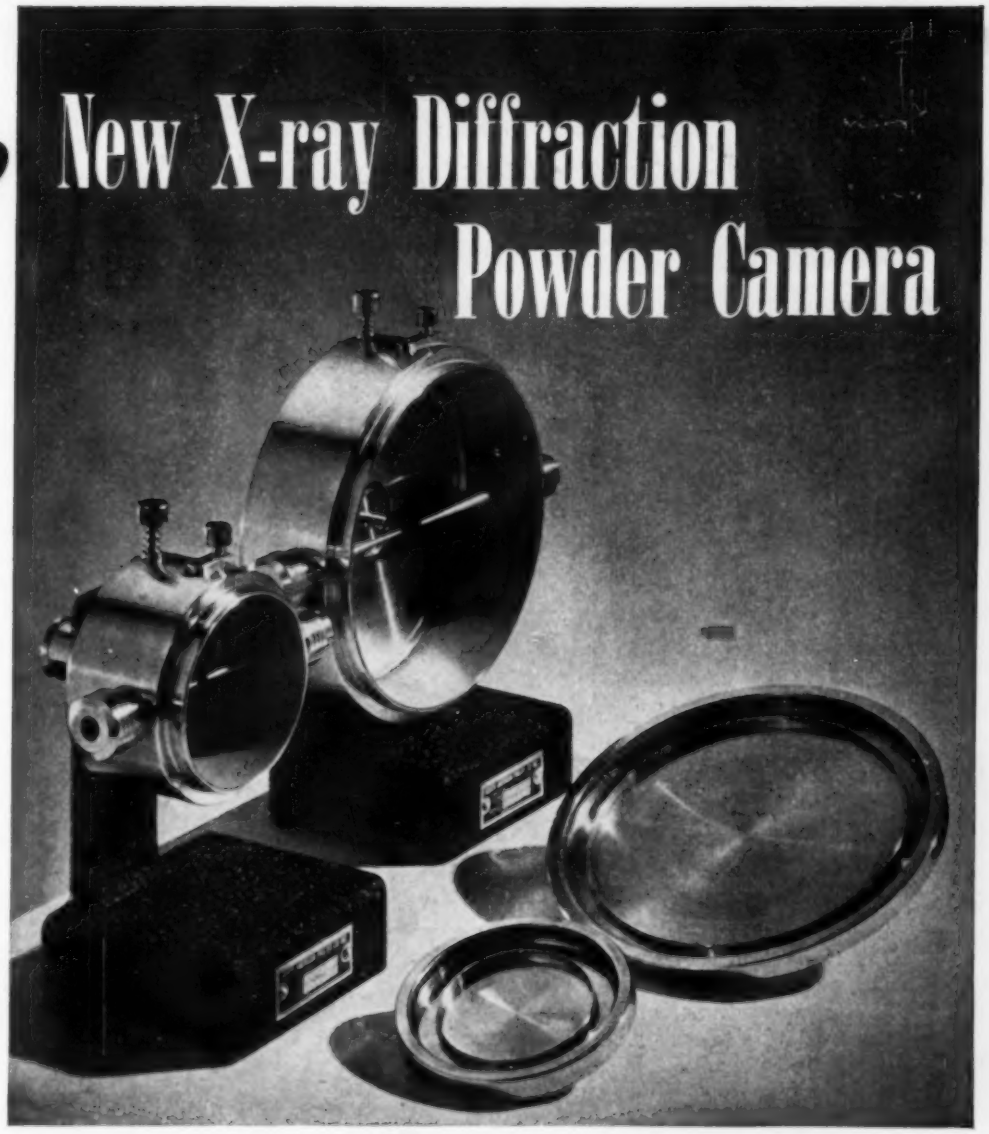

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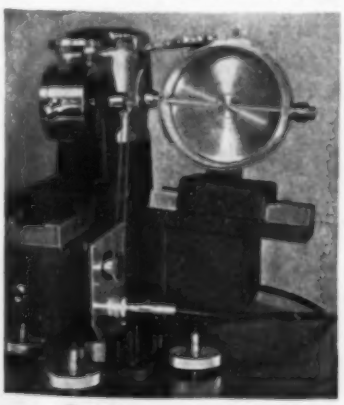

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Florida Scrub Oak—New Source of Vegetable Tannin. By H. N. Calderwood and W. D. May, Florida Engineering and Industrial Experiment Station, Gainesville, Fla. 3 pages.

Basic Criteria Used in Wage Negotiations. By Sumner H. Slichter. Published by The Chicago Association of Commerce and Industry, 1 North LaSalle St., Chicago 2, Ill. 56 pages. 50 cents. Importance and economic implications of wage criteria.

Synthetic Food Adjuncts. By M. B. Jacobs. D. Van Nostrand Co., 250 Fourth Ave., New York, N. Y. 335 pages. $5.50. Synthetic coloring and flavoring materials, chemical preservatives and stabilizers, and their use.

Textile Chemical Specialty Guide. 1946-47 edition. Published by Textile Book Publishers, Inc., 303 Fifth Ave., New York 16, N. Y. 405 pages. $6. Buyers' guide listing offerings of 193 manufacturers—listed by company, use, and by name.

Persistency of Odor of Accidentally Released "Pyrofax" Liquefied Petroleum Gas. By A. F. Matson and R. E. Dufour. Bulletin No. 37, published by Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago 11, Ill. 22 pages. Results of an investigation to determine whether or not the ethyl mercaptan odorant is removed or separated after accidental release of Pyrofax in rooms under conditions that may be met in practice.

A.S.T.M. Specifications for Steel Piping Materials. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 296 pages. $3. Pipe, tubes, cover castings, forgings and welded fittings, carbon and alloy steel bolting.

Symposium on Adhesives. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 61 pages. $1. Types, uses, theory of adhesion, properties, tests and specifications.

The Theoretical Basis of Adhesion. By W. A. Weyl. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 14 pages. 50 cents. Reprint of an address before the 1945 annual ASTM meeting.

Distribution of Ferric Chloride Between Isopropyl Ether and HCl in Stainless Steel Salvaging Process. By R. Mccormack and F. C. Vilbrandt. Bulletin No. 64, published by Virginia Polytechnic Institute, Blacksburg, Va. 10 pages. 25 cents. Report of a study undertaken to work out a practical process for production of nickel and chromium salts.

50 Years. Published by Crouse-Hinds Co., Syracuse, N. Y. 48 pages. A history of this half-century-old company.

Mold and Mildew Control. By S. S. Block. Bulletin 12, published by the Florida Engineering and Industrial Experiment Station, Gainesville, Fla. 50 pages. Mildew control in storage rooms and bakeries, on leather, fabrics, paints, ropes and books. Data are given on some fungicides.

Benzene. Published by Division of Labor Standards, U. S. Department of Labor, Washington 25, D. C. 24 pages. Sixth in the "Controlling Chemical Hazards" series. Fire hazards, storage, and personnel protection.

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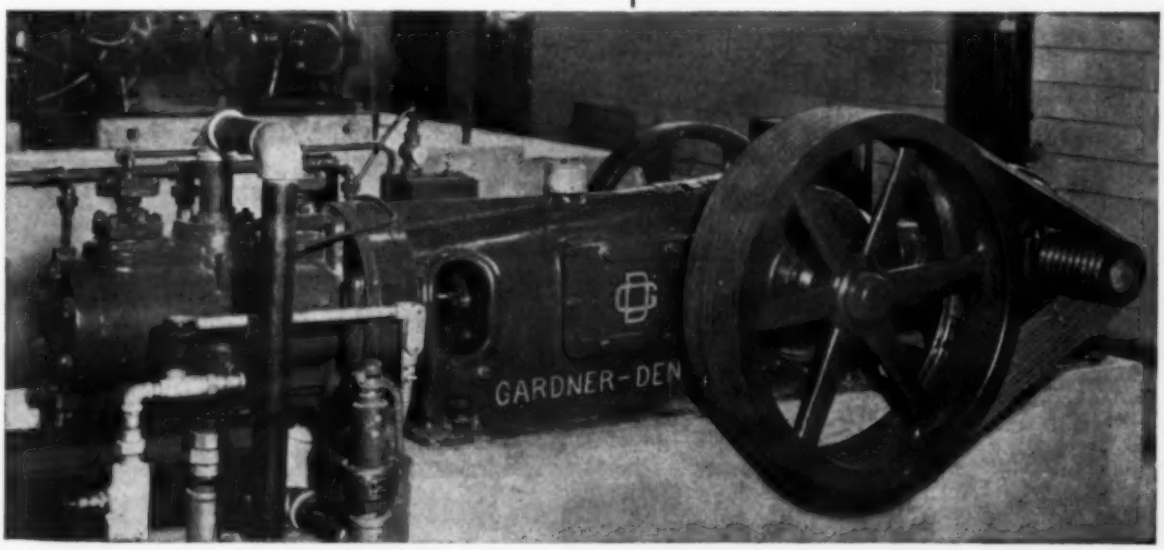

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Federal Labor Laws and Agencies. Department of Labor, Labor Standards Division, Bulletin 79. Price 20 cents.

Carbonizing Properties of Elkhorn No. 3-Bed Coal from Wheelwright Mine, Floyd County, Ky. By D. A. Reynolds, et al. Bureau of Mines, Technical Paper 697. Price 15 cents.

Root Development and Ecological Relations of Guayule. By Cornelius H. Muller. Department of Agriculture, Technical Bulletin No. 923. Price 25 cents.

Interrelation of Color Specifications. By Dorothy Nickerson. Department of Agriculture, Production and Marketing Administration. Unnumbered, mimeographed.

Pyrethrum-Oil Sprays in Open-Type Tobacco Warehouses. By Joseph N. Tenhet. Bureau of Entomology and Plant Quarantine, E-717. Mimeographed.

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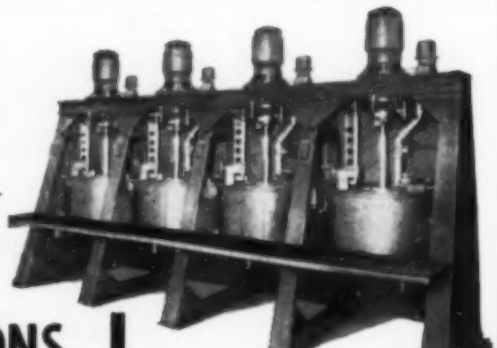

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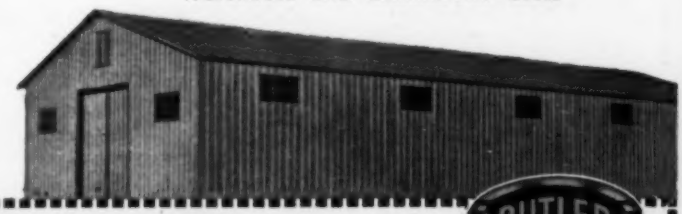

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Exploration of Poor Man Iron Deposit Kasaan Peninsula, Prince of Wales Island Southeastern Alaska. By S. P. Holt and R. S. Sanford. Bureau of Mines, Report of Investigations R. I. 3956. Mimeographed.

Exploration of Chamberlain-Barnardville Iron Deposits, Roane County, Tennessee. By Patrick D. McMaster. Bureau of Mines, Report of Investigations R. I. 3957. Mimeographed.

Moisture Relations of Tire Cords in Tires. By Helmut Wakeham, et al. Bureau of Agricultural and Industrial Chemistry, AIC-127. Mimeographed.

Educational Associations and Directories. Part IV of Educational Directory 1945-1946. U. S. Office of Education. Price 15 cents.

Alaska's Mineral: as a Basis for Industry. By H. Foster Bain. Bureau of Mines, Information Circular I.C. 7379. Mimeographed.

A Review of the Insecticidal Uses of the Rotenone-Bearing Plants, 1938-1944. By N. E. McIndoo. Bureau of Entomology and Plant Quarantine, E-713. Mimeographed.

Products of American Forests. By J. Alfred Hall and T. J. Mosley. Department of Agriculture, Forest Service. Price 20 cents. A brief general survey.

Passage of Liquids, Vapors, and Dissolved Materials Through Softwoods. By Alfred J. Stamm. Department of Agriculture, Technical Bulletin No. 929. Price 25 cents.

Geology and Ground-Water Resources of Cedar City and Parowan Valleys, Iron County, Utah. By H. E. Thomas and G. H. Taylor. Geological Survey Water-Supply Paper 993. Price $1.25.

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Charter for an International Trade Organization, issued in December 1946 by U. S. Department of State following London meeting of last winter. U. S. Tariff Commission. Unnumbered. Mimeographed.

A Guide for the Placement of the Physically Impaired. U. S. Civil Service Commission, Pamphlet 14, Fourth Edition. Price 60 cents.

Extent of Collective Bargaining and Union Recognition, 1946. Bureau of Labor Statistics, Bulletin 865. Price 5 cents.

Bureau of Mines Papers Published in the Technical Press, January 1, 1938 to January 1, 1946. Bureau of Mines. Mimeographed. A bibliography.

Capitain Iron Deposits, Lincoln County, New Mexico. By John H. Soulé. Bureau of Mines, Report of Investigations R. I. 4022. Mimeographed.

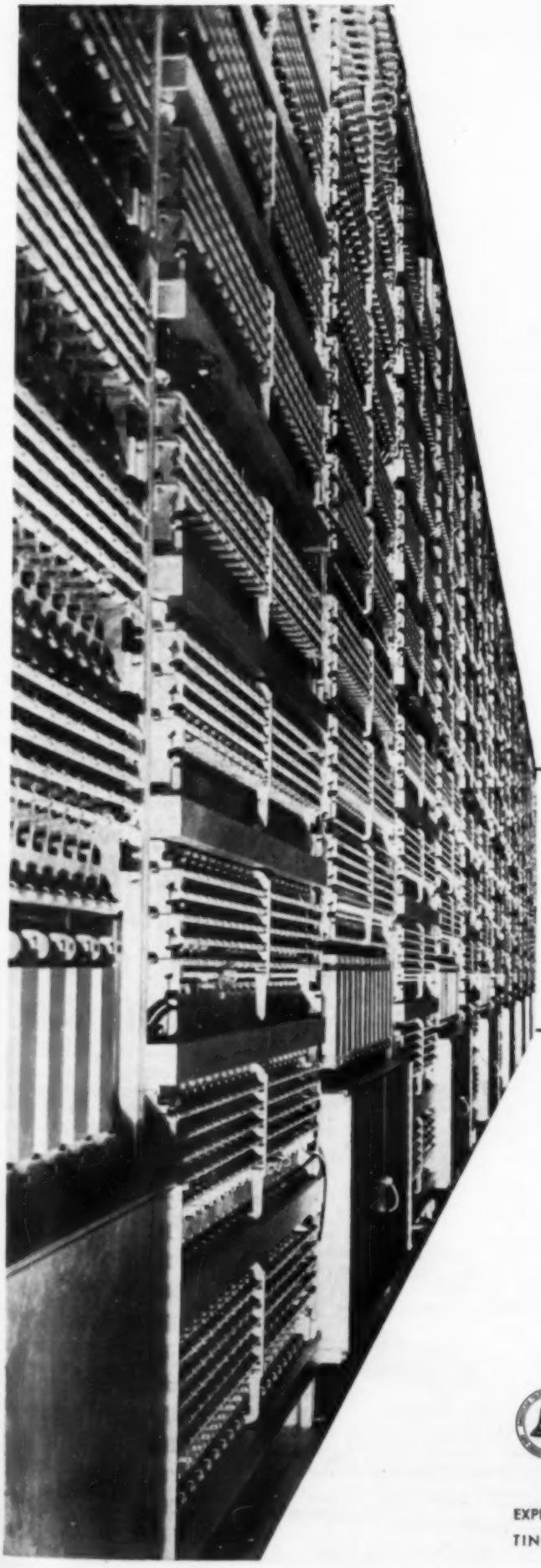
Apache Mica Mine, Rio Arriba County, New Mexico. By Ray J. Holmquist. Bureau of Mines, Report of Investigations R. I. 4037. Mimeographed.

Control of Sulfur Content of Sponge Iron Produced in Rotary Kilns. By R. C. Buehl, et al. Bureau of Mines, Report of Investigations R. I. 4057. Mimeographed.

Reduction of Magnesium Chloride by Calcium Carbide. By Lloyd R. Michels, et al. Bureau of Mines, Report of Investigations R. I. 4059. Mimeographed.

Beneficiation of New England Beryllium Ores. By Frank D. Lamb. Bureau of Mines, Report of Investigations R. I. 4040. Mimeographed.

Utilization of Natural Gas for Chemical Products. By Harold M. Smith and W. C. Holliman. Bureau of Mines, Information Circular I. C. 7347. Mimeographed.



WHEN you spin the dial of the latest type of telephone system—known as "common control switching"—you order into action a giant nervous system. It sends electrical impulses through an intricate maze of circuits: more than 10,000 contacts can be opened or closed in a single dial call.

This system takes your order, remembers it, translates it into its own electrical language, throws out sensitive "feelers" to find a through route, plans how to make the connections, makes them, puts through the call—and, if the preferred paths are busy, finds an alternate route to take the call.

The complex art of telephone switching is brought to a high state of development at Bell Laboratories to serve the Bell System. Some day through "common control switching" a dial in San Francisco may set up a connection through to a subscriber in New York.

Left: Backstage on your dial telephone call—some equipment in a typical "common control switching" office.

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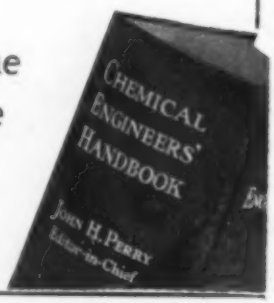

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(Continued from page 184)

these impurities. Diagrammatic sketches show the various types of equipment offered for this work.

112. Instruments. The Bristol Co., Waterbury, Conn.—Bulletin W1811 lists over one hundred and fifty different items of recording and controlling instruments available from this company. Contains information on thermometers, pyrometers, pressure gages, voltmeters, ammeters, and pH recorders. Also contains information on miscellaneous instruments and accessories.

113. Radioactivity. Tracerlab, Inc., Boston, Mass.—12-page illustrated monthly bulletin giving technical information on laboratory, medical and industrial use of radioactivity. This company's instruments and equipment for the measurement of radioactivity are described.

114. Protective Coatings. L. Sonneborn Sons, Inc., New York, N. Y. 4-page folder illustrating and describing the use of Hydrocide Colorless, an invisible water repellent treatment for exterior concrete and masonry building walls. Includes test data comparing this material with other types of exterior treatment.

115. Instruments. Bailey Meter Co., Cleveland, Ohio—Bulletin 105-B is a 16-page booklet illustrating and describing the Bailey three-element feedwater control system. Operation is described in detail and is illustrated by means of a schematic multi-color diagram. Operating features are described and several pages are devoted to showing the chart records obtained by use of this system.

116. Chemicals. Oldbury Electrochemical Co., Niagara Falls, N. Y.—24-page booklet lists and describes the various products made by this company. The data given for each item includes formula, molecular weight, grades, physical properties, specifications, uses, how packaged, shipping regulations, and precautions. It is an excellent booklet.

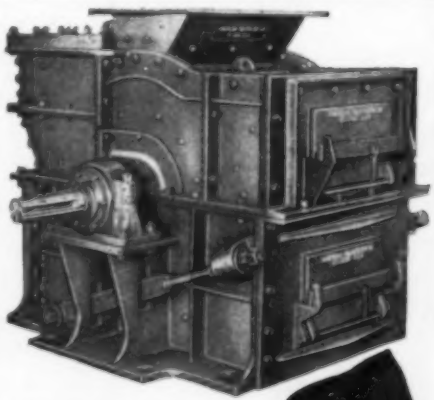
117. Plastic Molding Presses. The Baldwin Locomotive Works, Philadelphia, Pa.—Bulletin 251 illustrates and describes the high-speed compression molding presses and high-speed universal plunger molding presses now available for production of molded plastics and soft rubber products.

118. Packaging. St. Regis Paper Co., New York, N. Y.—4-page leaflet illustrating and describing the use of multiwall paper bags in the packaging of powdered materials.

119. Industrial Models. Stark Industrial Models, New York, N. Y.—4-page folder featuring the use of industrial models is entitled "How Industrial Models Can Help Your Firm." Illustrates four general types of industrial models now being used and suggests the adaptations possible in other industries.

120. Packings. Raybestos - Manhattan, Inc., Manheim, Pa.—16-page catalog containing illustrations and descriptions of the most popular styles of mechanical packings made by this company. Includes a recommendation chart showing the style numbers of packings recommended for various types of service.

121. Instruments. Northern Equipment



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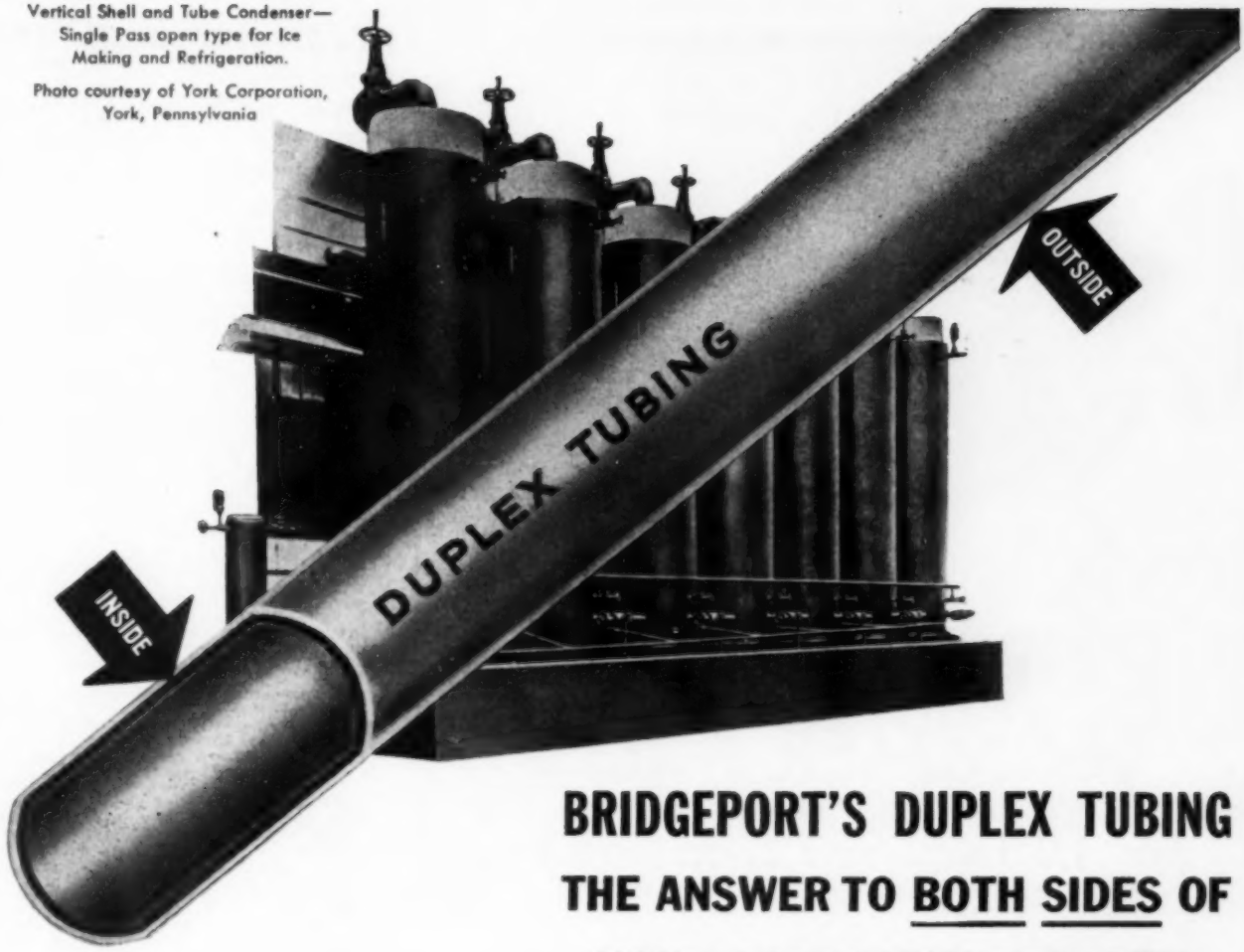

Vertical Shell and Tube Condenser—Single Pass open type for Ice Making and Refrigeration.

Photo courtesy of York Corporation, York, Pennsylvania

BRIDGEPORT'S DUPLEX TUBING

THE ANSWER TO BOTH SIDES OF YOUR CORROSION PROBLEM

Interrupted service due to premature failure of heat exchanger tubing can often be avoided by studying the nature of the corrosive media which exist both inside and outside of the tubing. By selecting the material which will resist inside corrosion and another to withstand outside corrosion, and combining them in the form of Duplex Tubing, a troublesome and difficult problem can often be solved.

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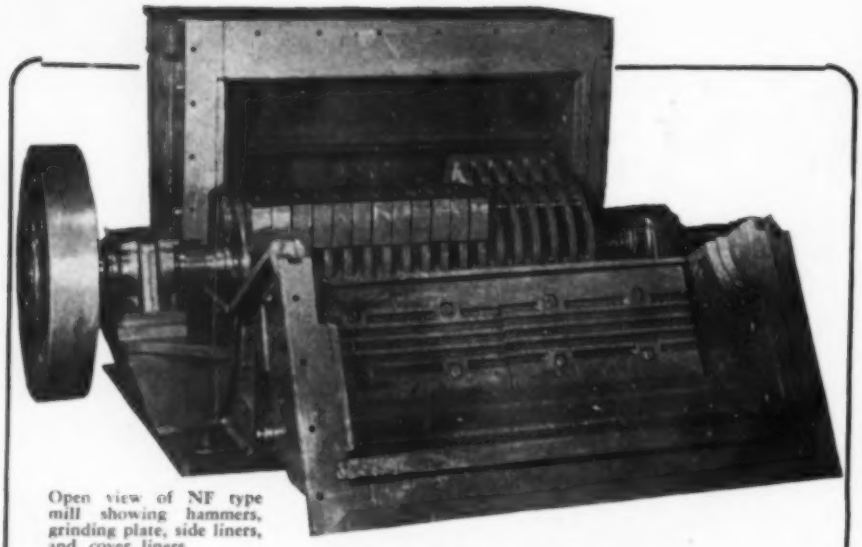

Open view of NF type mill showing hammers, grinding plate, side liners, and cover liners

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Co., Erie, Pa.—Bulletin 485 illustrates and describes the Copes system of boiler water level control as applied to a large power plant.

122. Air Conditioning. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 25B6183 is a 12-page booklet illustrating and describing equipment for heating, ventilating and air-conditioning for use in a wide variety of applications. Includes information on Texrope V-belt drives, centrifugal pumps, a.c. and d.c. motors, motor controls, transformers and welders.

123. Glassware. Corning Glass Works, Corning, N. Y.—Supplement No. 3 to Glassware Catalog LP24 contains price revisions on laboratory glassware made by this company.

124. Ovens. Gehnrich Oven Division, W. S. Rockwell Co., Brooklyn, N. Y.—Catalog 114. 28-page booklet describes and illustrates the ovens made by this company for use in baking, drying and curing for various industries such as paint, enamel, lacquer, varnish finishes on metal, wood or glass, electrical insulation, abrasives, ceramics, chemicals, etc. Diagrammatic sketches are used to illustrate these applications.

125. Thermostat. Fenwal, Inc., Ashland, Mass.—Catalog on thermoswitch controls illustrates and describes the equipment manufactured by this company. Principle of operation is described and illustrated by cutaway views. Cross-sectional diagrams show the construction of each of the different devices.

126. Instruments. Fischer & Porter Co., Hatboro, Pa.—Catalog 25-E illustrates and describes the Series 700 Flowrator made by this company. Construction details are illustrated by schematic diagrams.

127. Resins. Centro Research Laboratories, Inc., Briarcliff Manor, N. Y.—4-page leaflet listing standard synthetic resin solutions for use in research and development work.

128. Materials Handling. Trackson Co., Milwaukee, Wis.—2-page leaflet featuring the Model T6 Traxcavator, a tractor-excavator which combines the usefulness of a shovel, loader, scraper and bulldozer for use in handling various materials.

129. Floats. W. H. Nicholson & Co., Wilkes-Barre, Pa.—Bulletin 746 contains eight pages describing welded floats made of stainless steel, Monel, or chromium plated steel. These spherical, elliptical and cylindrical shaped floats are available in sizes 2 to 14 in. in diameter for use in various applications such as in refineries, dairies, canneries, etc.

130. Hose Clamps. Aircraft Standard Parts Co., Inc., Rockford, Ill.—4-page leaflet featuring the worm drive hose clamps made by this company. These clamps have a special screw device for tightening. Contains a price list.

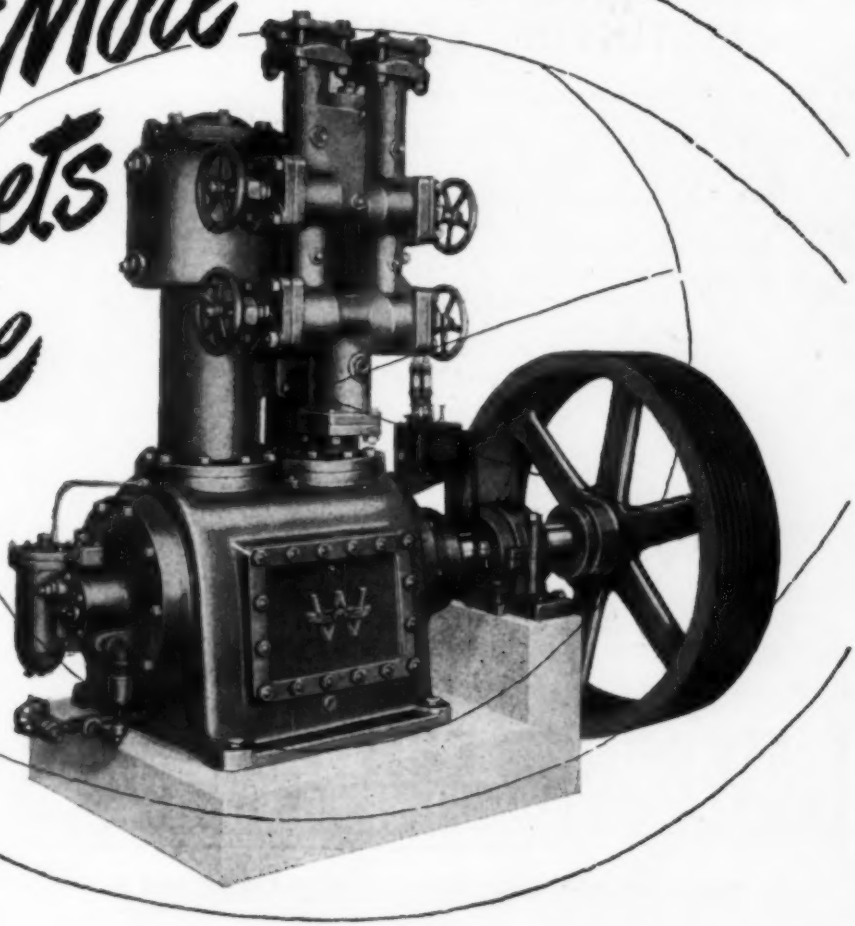
131. Air-Handling Equipment. American Air Filter Co., Inc., Louisville, Ky.—Bulletin 272A. 19-page illustrated booklet featuring the Type D Roto-Clone precipitator for use in the dry collection of a wide variety of granular industrial dust. Principle of operation is described and illustrated by cross-sectional diagrams. Detail drawings giving various dimensions are shown. Includes blower performance characteristics for the various types of equipment. Contains a section on the design and installation of complete dust control systems.

132. Instruments. American District Steam Co., N. Tonawanda, N. Y.—Bulletin 3580B illustrates and describes the Adsco rotary condensation meter available for capacities of 250 to 12,000 lb. of condensate per hour. Includes complete details of construction and installation.

133. Instruments. Jas. T. Marsh Corp., Chicago, Ill.—Two booklets describing the pressure gages and thermometers made by this company. Illustrates and describes refrigeration instruments and other gages.

134. Pumps. Geo. D. Roper Corp., Rockford, Ill.—Catalog 947. 8-page booklet illustrating and describing this company's rotary pumps for manufacturing, marine, petroleum and process industries. Includes specifications, dimensions, and other operating information on the various types of pumps. It is well

You Get More Than Meets the Eye



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- All sizes have main bearings of self-aligning, double-row roller type. Three larger units equipped with outboard bearings incorporating same features.
- Cylinders, bearings and pins are pressure lubricated.
- Large area Feather* Valves . . . the lightest, quietest, most efficient ever designed for compressors . . . are used on suction and discharge.
- Safety head on discharge reduces slop-over hazard.
- Trouble-free two-piece construction of Worthington QD Sheave and Hub combines the three basic sheave requirements: *Easy to Get On, Easy to Get Off, Yet Always Tight on the Shaft.*
- Manifold of the unit type . . . with stop, by-pass and pump-out valves . . . improved quick-opening relief valve.

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THINGS YOU CAN'T SEE . . . include Worthington's *skill in application* that accounts for the vast number of Worthington installations in the food industry . . . Worthington *engineering ability* that has solved hundreds of difficult problems in gas compression . . . Worthington *manufacturing skill* that accounts for Worthington's large production of critical components for the high side of the refrigeration cycle. All these factors enable Worthington to offer you an integrated, efficient installation that exactly fits your needs.

For further proof that *there's more worth in Worthington*, talk things over with your nearby Worthington Distributor, or write for Bulletin direct to *Worthington Pump and Machinery Corporation, Harrison, N. J. Specialists in air conditioning and refrigeration machinery for more than 50 years.*

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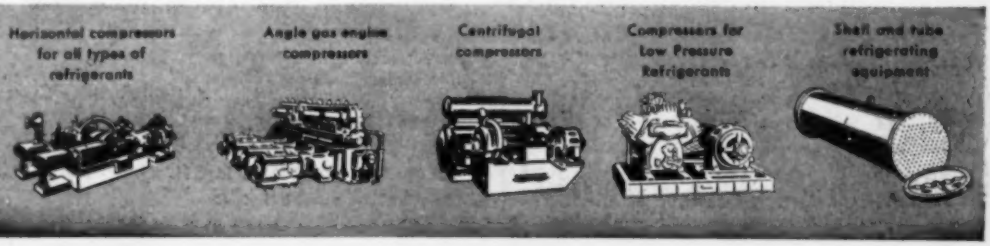
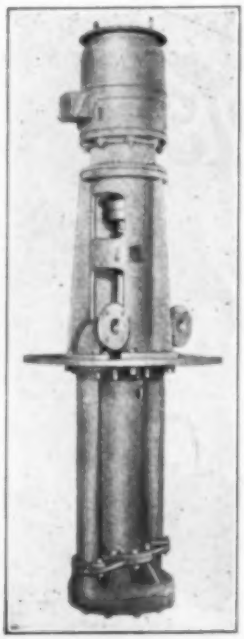
FIVE MORE REASONS WHY WORTHINGTON LEADS IN INDUSTRIAL REFRIGERATION


Horizontal compressors for all types of refrigerants
Angle gas engine compressors
Centrifugal compressors
Compressors for Low Pressure Refrigerants
Shell and tube refrigerating equipment

A SUBMERGED PUMP with BEARINGS and STUFFING BOX ACCESSIBLE

The fluid handled is a combined corrosive-abrasive mixture, contained in closed tanks. Lawrence engineers designed, for this purpose, this LAWRENCE VERTICAL CENTRIGUGAL PUMP with an extra heavy shaft having its two bearings and stuffing box outside of the tank. And, to avoid excessive vibration, the pump casing has two opposite discharge openings which equalize the side thrust on the impeller. All submerged parts are of a special alloy highly resistant both to corrosive and abrasive action of the mixture pumped . . . May we help you to bring your pumping cost down—and keep it down?



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illustrated with photographs and drawings.

135. Wood Rolls. Timber Engineering Co., Washington, D. C.—4-page folder illustrating and describing laminated wood rolls made by this company.

136. Instruments. Photoswitch, Inc., Cambridge, Mass.—Several bulletins describing the various instruments made by this company. These include Bulletin 504 covering the general line of equipment made by this company; Bulletin 201-T on level controls; Bulletin 902-A on timers. Sheet 1302 describes smoke density indicators and recorders. Price List No. 504-G gives the price schedules for this company's equipment as of December, 1946.

137. Power Plant Equipment. Schutte & Koerting Co., Philadelphia, Pa.—4-page multi-color diagrammatic layout illustrating the application of this company's equipment in a typical high-pressure power plant. This includes valves, eductors, syphons, heat transfer equipment, rotameters, and other similar items.

138. Furnaces. Air Devices, Inc., New York, N. Y.—12-page illustrated booklet describing the direct-fired hot gas generating industrial furnaces for process drying and product heating. Details of construction and operation are pictured and described in detail. Various types of applications are described. Includes a capacity table for the various types of units with capacities of 600,000 to over 100,000,000 B.t.u. per hr.

139. Heat Treating. Tempil Corp., New York, N. Y.—Multi-color chart entitled "Basic Guide to Ferrous Metallurgy," which shows the working characteristics of steel at temperatures from minus 300 deg. F., to 2,900 deg. F.

140. Insulated Wire. Simplex Wire & Cable Co., Cambridge, Mass.—12-page booklet featuring the synthetic rubber insulated wire made by this company.

141. Aluminum Ladders. Aluminum Ladder Co., Worthington, Pa.—12-page booklet entitled "The Story of Aluminum Ladders" describes and illustrates some of the ladders made by this company for various applications.

142. Voltage Regulators. Sorensen & Co., Inc., Stamford, Conn.—16-page booklet containing complete information on this company's line of electronic apparatus, which describes the principles of operation of the electronically controlled voltage regulators.

143. Protective Coatings. Rheem Research Products, Inc., Baltimore, Md.—4-page folder describing this company's anti-corrosion coatings for use on zinc or cadmium surfaces.

144. Instruments. Calco Chemical Division, American Cyanamid Co., Bound Brook, N. J.—Technical bulletin No. 792 describes the Dyeometer, an instrument for studying color reactions.

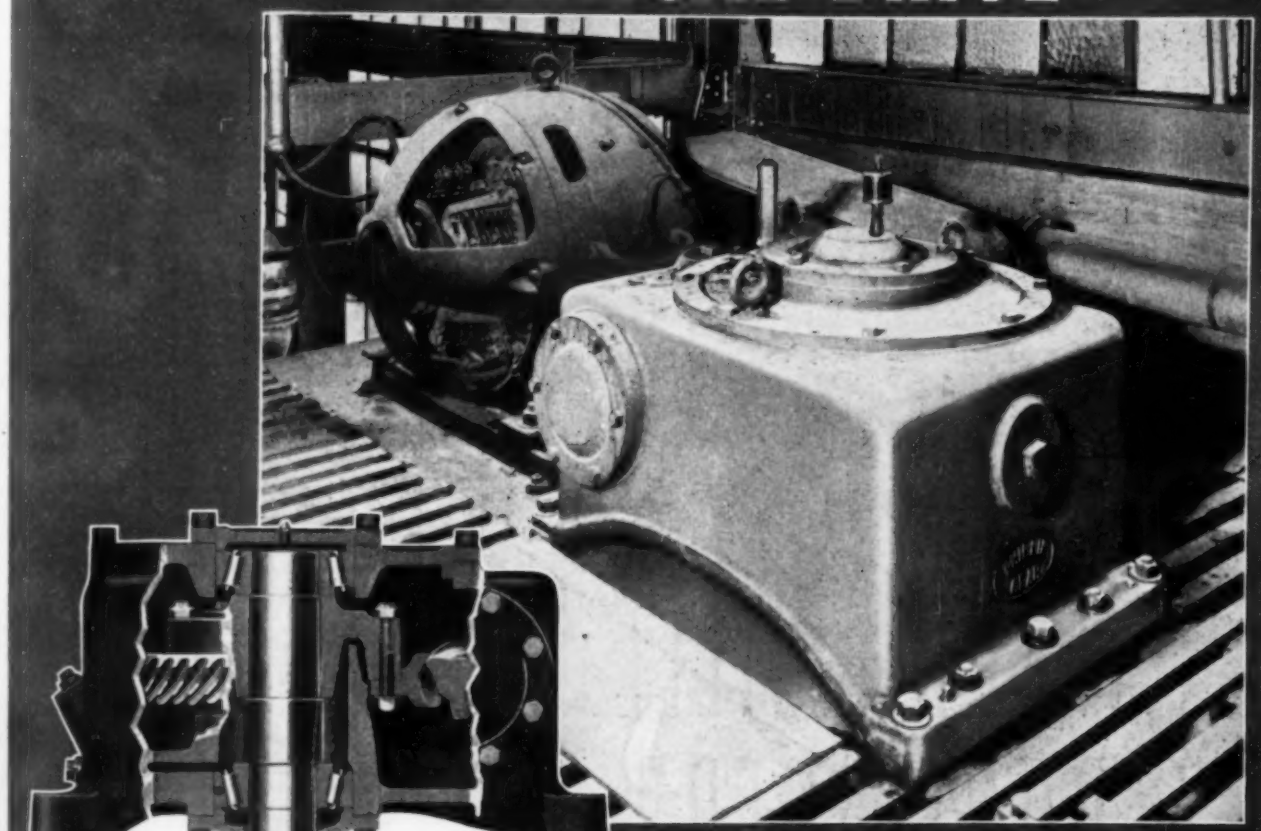
145. Pumps. Lawrence Machine & Pump Corp., Lawrence, Mass.—Bulletin 205-2. 4-page leaflet illustrating and describing the high density centrifugal paper stock pump made by this company. Specifications are given for this pump which is illustrated by a cross sectional diagram. Different types of horizontal and vertical type pumps are shown.

146. Silica Gel. Davison Chemical Corp., Baltimore, Md.—12-page booklet entitled "Fundamental Phenomena of Dehumidification." An excellent technical booklet describing basic relationships involved in dehumidification, physical factors in dehumidification, and various applications. The action of silica gel for dehumidifying material inside of packages is illustrated by two-color charts. Form No. 39n is a 6-page leaflet entitled "Chromatographic Adsorption and Silica Gel" gives a good description of this phenomenon. Form No. 40 contains

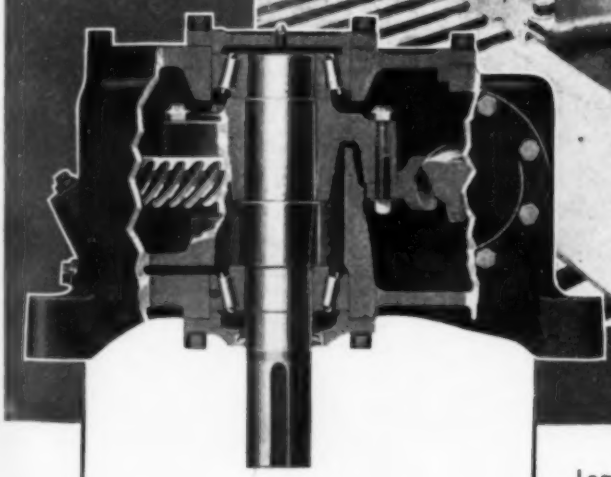
WIDELY USED IN THE PROCESS INDUSTRIES . . .

OIL-TIGHT

VERTICAL DRIVE



IT'S A PHILADELPHIA
WORM GEAR SPEED REDUCER



The cut-away view clearly shows the leak-proof design of the Type VT, Heavy Duty, Vertical Worm Gear Reducer. This section through the gear shaft assembly shows the unique "dry-well" construction that makes oil leaks down the vertical shaft impossible. An oil seal inserted in the bottom plug, seals-in lower bearing grease. *Note:* This same unit is available with the worm shaft extended upward.

Leak-proof construction, plus dependable, trouble-free service were the important factors in the selection of Philadelphia Vertical Worm Gear Reducers for mounting over pans in the large eastern Sugar Refinery shown above.

Tight housings, amply proportioned for heat radiation, keep out dirt and provide rigid mountings for bearings . . . and the Worm and gear turn in an oil bath.

Philadelphia Worm Gear Units are made in vertical and horizontal types, in a full range of horsepowers and reduction ratios. For full details write for latest catalog . . . on your business letterhead, please.

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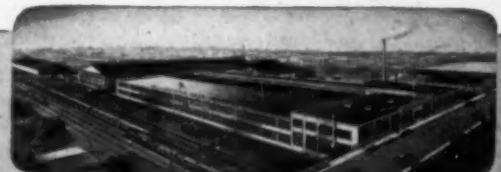

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8 pages describing the fluid process for catalytic cracking and its use of silica gel. Also a loose leaf section, form No. 39A, consisting of a series of product data sheets which give the physical and chemical properties, grades, uses, and other information regarding the various chemical products made by this company.

147. Electric Motors. Reliance Electric & Engineering Co., Cleveland, Ohio.—Bulletin C-118 of 4 pages illustrating and describing the protected open type electric motors made by this company. Bulletin C-125 describes the totally enclosed, fan-cooled Series C motors.

148. Compressors. Clark Bros. Co. Inc., Olean, N. Y.—20-page reprint featuring the compressors used in the South Cole Levee unit pressure maintenance project.

149. Chemicals. Armour & Co., Chicago, Ill.—10-page technical booklet entitled "The Chemistry of Fatty Acids" is a comprehensive treatment of this subject. It illustrates and describes various types of reactions, including oxidation, polymerization, hydrogenation, halogenation, sulfonation, and reactions involving esters, anhydrides, ketenes, ketones, alcohols, etc.

150. Silicones. Dow Corning Corp., Midland, Mich.—4-page leaflet describing the properties and uses of DC anti-foam A, a silicone compound for killing foam in aqueous systems.

151. Equipment. Portable Products Corp., Pittsburgh, Pa.—28-page booklet illustrating and describing the products of various divisions of this company. Included is a section describing the instruments made by the C. D. Tagliabue Division.

152. Mixers. Struthers Wells Corp., Process Equipment Division, Warren, Pa.—Bulletin No. 55W contains 4 pages illustrating and describing this company's rubber cement mixers. Detailed diagrams with dimensions are given.

153. Luminescent Pigments. The New Jersey Zinc Co., New York, N. Y.—Pocket size booklet entitled "101 Useful Luminescent Applications." Both fluorescent and phosphorescent types of applications are included using luminous pigments as paints, plastics, papers, printing, decals, silk screen printing paints and porcelain.

154. Instruments. The Eppley Laboratory, nc., Newport, R. I.—4-page mimeographed pamphlet describing the Golay infrared detector manufactured by this company. Cross sectional diagram illustrates principle of operation.

155 Packing Rings. Raybestos Manhattan, Inc., Manheim, Pa.—4-page booklet, form No. A909, illustrates and describes the Vee-Flex packing rings made by this company. Diagrams show the method of measuring a stuffing box for this type of packing as well as showing methods of installation.

156. Deaerators. Elliott Co., Jeannette, Pa.—Bulletin N-15 is a 20 page booklet describing and illustrating the deaerating equipment made by this company. Contains a discussion of why corrosion makes deaeration of feedwater necessary. Principles of deaeration are described in detail and the various types of equipment used in this process are illustrated.

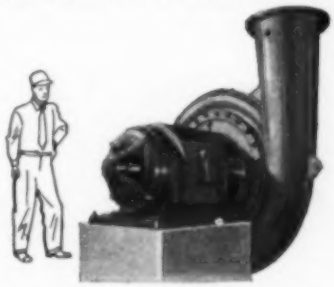
157. Instruments. The Bristol Co., Waterbury, Conn.—2-page leaflet describing a typical application of this company's tachometers for recording paper speed through a paper machine.

158. Casters. The Rapids-Standard Co., Inc., Grand Rapids, Mich.—Catalog 65-3 40-page booklet illustrating and describing the complete line of casters made by this company.

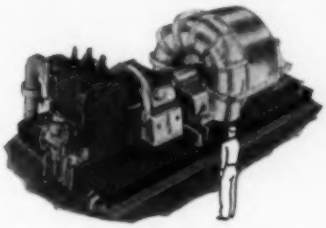
159. Textile Chemicals. Dexter Chemical Corp., New York, N. Y.—Two pieces of literature are now available from this company. One is a folder containing information on the problem of level dyeing of wool and the second contains a series of reprints dealing with various phases of the textile processing industry.

160. Valves. McAlear Mfg. Division of Climax Industries, Inc., Chicago, Ill.—Bulletin No. 118B is a 2-page leaflet featuring the Macalator Flexifram valve made by this company. Details of construction are given and a list of liquids

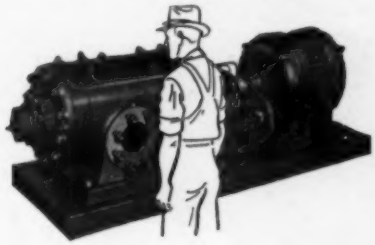
DOES YOUR PROCESS CALL FOR Air or Gas?



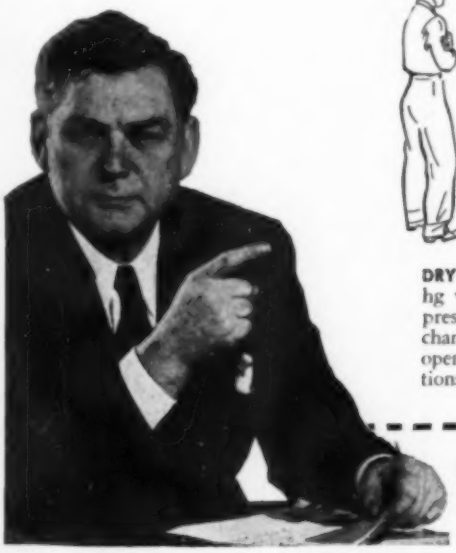
SINGLE STAGE BLOWERS. Available in pressure ranges from one to 6.50 lbs. Features: Discharge nozzle can be arranged 24 ways. Cast casing provides rigidity, longer life, smoother operation . . . deadens machine noises, eliminates vibration.

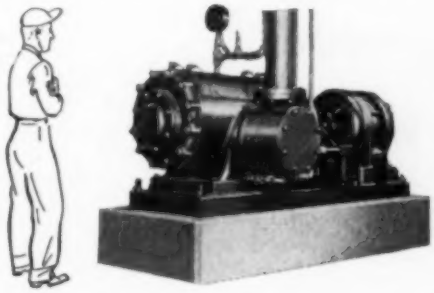


MULTI-STAGE BLOWERS. Inlet volumes up to 130,000 cfm, pressure to 35 lbs gauge, uncooled. Centrifugal type, for boosting, exhausting, circulating. Cannot build up dangerous pressures. Pressure volume curve favorable to parallel operation.

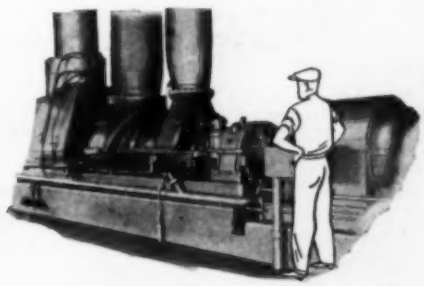


ROTARY COMPRESSORS, sliding vane type. Capacities for 5 to 35 psig. Air is compressed in cells formed by blades moving freely in and out of longitudinal slots in rotor. Quiet, smooth operation. Notably low maintenance. Units start unloaded.





DRY VACUUM PUMPS. Range to 28½ inches hg vacuum. Same principle as rotary compressors except that inlet is hooked up to chamber to be evacuated and exhaust is open. Operates free of vibrations or pulsations. No inside valves. Saves floor space.



AXIAL COMPRESSORS. Compress to 60 lbs, gauge with high efficiencies. *Good base load machines.* Handle large fixed volumes with pressure variations over a comparatively wide range. Used in connection with *gas turbines.* Cannot build up dangerous pressures.

WHETHER FOR AERATION, AGITATION, CIRCULATION OR COMBUSTION . . . ALLIS-CHALMERS BUILDS 5 TYPES OF EQUIPMENT TO HELP YOU!

THIS WIDE RANGE simply means that you can be *assured* of equipment that will "tailor-fit" your process.

Allis-Chalmers experience in air and gas handling equipment dates back half a century. A-C *developed* the use of turbo-blowers in the U.S., as well as the sliding vane principle that established *rotary-type* compressors and vacuum pumps.

In addition, Allis-Chalmers builds *other* types of high-speed rotating machinery—thus, can guarantee coordinated drive and power requirement.

This combined experience is practical evidence of Allis-Chalmers ability to help solve your problems.

A qualified engineer in our nearby Sales Office is ready to discuss your future needs, whether for standard or specially designed units. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2196

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

Clean Grounds

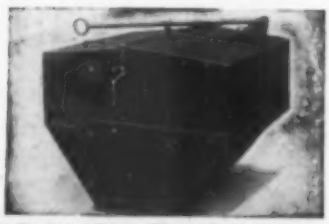
.... at HALF THE COST

SAVE TIRES - TRUCKS - MANPOWER

with a Brooks **LOAD LUGGER**

Standard Tilt-Type Bucket

Open-End Skip-Type Bucket



Enclosed-Type Water-Tight Bucket

Hundreds of firms are finding the Brooks Load Lugger indispensable in their various loading, hauling and dumping operations. Keeping grounds clean, collecting and carrying away furnace residue, loading and hauling plant waste, transporting finished and unfinished products—in short, almost any type of materials handling is facilitated with this highly versatile system. Operates hydraulically from power take-off . . . is one-man controlled . . . needs only 15 seconds for loading or dumping.

A Brooks Load Lugger installed on one of your trucks serves any number of detachable bucket bodies spotted at various loading points throughout your plant and grounds. Your loading crew keeps busy constantly loading, while the truck is constantly hauling, dumping, returning an empty bucket and picking up the next full one. And there's a bucket for every type of material whether light or heavy, liquid or dust, hot or cold. Write for catalog 1-A, today.

510 DAVENPORT ROAD, KNOXVILLE 8, TENN.

Distributors in all Principal Cities

Brooks EQUIPMENT AND MFG. CO.

or gases that can be handled by this valve are tabulated.

161. Pumps. Economy Pumps, Inc., Hamilton, Ohio—Catalog No. B-1146. 6-page folder featuring the Type CS vertically split case multi-stage pump made by this company. Details of construction are described and illustrated. Approximate weights and outline dimensions are tabulated and are shown by diagrammatic sketches. Performance curves are included.

162. Line Blinds and Valves. Hamer Oil Tool Co., 2919 Gardenia Ave., Long Beach, 7, Calif.—50-page catalog describing line blinds and plug valves available from this company. Includes data on specifications, applications, prices, installation and operating instructions. Illustrated.

163. Lift Truck. Towmotor Corp., Cleveland, Ohio—An illustrated booklet featuring the use of fork lift trucks in handling materials in a plant which manufactures glass jars, bottles, seals and caps.

164. Machine Tools. Benchmaster Manufacturing Co., 2952 West Pico Blvd., Los Angeles 6, Calif.—8-page illustrated bulletin describing this company's inclinable punch presses, milling machines and bench accessories such as rotary tables, collets and swivel vises.

165. Cycling Plant. Fluor Corp., Ltd., 2500 South Atlantic Blvd., Los Angeles, Calif.—32-page illustrated booklet describing the South Coles Levee, Calif., natural gas cycling plant which was designed and constructed by this company. Included is a four-color flow sheet showing the well gas and condensate processing stages.

166. Salt. Leslie Salt Co., 310 Sansome St., San Francisco, Calif.—30-page pamphlet describing the method of evaporating, purifying, and packaging salt from ocean brines. Numerous photographs are included.

167. Packaging. Chase Bag Co., New York, N. Y.—16-page brochure featuring the various types of bags and packaging materials made by this company. Contains a brief history of this company which was founded in 1847.

168. Cleaning Chemicals. Pennsylvania Salt Mfg. Co., Philadelphia, Pa.—4-page leaflet giving instructions on cleaning and pickling cycles for preparing surfaces for enameling by use of this firm's chemicals.

169. Electrostatic Spraying. Harper J. Ranburg Co., Indianapolis, Ind.—12-page reprint entitled "Electrostatic Spraying and Electrostatic Detearing" which describes and illustrates these processes in some detail.

170. Pulverizers. Pulverizing Machinery Co., Summit, N. J.—48-page illustrated booklet describing the complete line of Mikro-Pulverizers, and Mikro-Atomizers made by this company. Contains information on basic principles and details of design and construction. Typical applications to various types of pulverizing processes are discussed.

171 Pump Governors. Leslie Co., Lyndhurst, N. J.—Bulletin 463, 16-page illustrated booklet giving engineering, operating and maintenance data on the pump governors for control of reciprocating, turbine, and motor-driven pumps. Construction details are shown in cross-sectional views, and capacity tables, specifications, sizes and other information are given.

172. Colors. Sun Chemical Corp., New York, N. Y.—Foldout sheet entitled "Color in Electromagnetic Energy." Contains a simplified spectrum chart and indicates the position on the chart of various practical applications such as induction heating, commercial broadcasting, television, radiant heating, etc. The portion of the spectrum giving off visible light is indicated.

FOR MORE INFORMATION
See Reader Service
Coupon on pages 183-184

CHEMICAL ECONOMICS

H. M. Ballers, MARKET EDITOR

SOME FALLING OFF INDICATED IN SECOND-QUARTER REQUIREMENTS FOR MANY CHEMICALS

FOLLOWING THE record heights reached in the first quarter of this year, there has been some drop in operating rates in industries which rate high as consumers of chemicals. Runs to stills at petroleum refineries in April represented a lower daily average than any of the preceding months of the year. Cotton mills, while maintaining a relatively high rate, are running considerably under their peak levels. A mixed situation exists at woolen mills with some operating on a full schedule and others closed because stocks have piled up and consuming outlets have narrowed. Paint distributors have not moved stocks in the volume anticipated and this situation has been reflected in operations at manufacturing plants.

On the other hand, producers of chemicals are holding a fairly steady course and the automotive industry made its best postwar showing in April. Steel mills also are operating at a high rate with similar reports coming from the glass, rayon, and paper industries. However, the spotty conditions which prevail make it fairly certain that total consumption of chemicals in the second quarter will fall short of that reported for the first quarter although the first six months of this year should show a volume gain of at least 10 percent over that for the comparable period of last year.

The Federal Reserve Board index for all production rose to 186 in March which was only one point above the revised figure for February. The preliminary index number for industrial chemicals which was placed at 435 for February has been revised to 429 and the preliminary for March is at the same level. The *Chemical Engineering* index for industrial consumption of chemicals, which dropped below 209 in February, rose to 224.79 in March. In March 1946, the Reserve Board index for industrial chemicals stood at 382 and the *Chemical Engineering* index for chemical consumption at 206.27.

In both production and consumption of industrial chemicals, the first quarter of this year represents a peak period, surpassing even the wartime highs. In that three-month interval, a new production record was written by the fertilizer industry. Sales of paint products were the highest ever reported. Glass outputs reached a new high. Soap makers, still handicapped by scarcities and high prices for raw materials, made a much better showing than in the first quarter of last year. Sales for the quarter, reported by 70 manufacturers representing about 90 percent of the industry, amounted to 678,379,000 lb. or 10.1 percent higher than those for the like period in 1946. In addition, there were sales of 967,655 gal. of liquid soaps, an increase of 6.6 percent in the comparative periods.

Chemical Engineering Index

Industrial Consumption of Chemicals

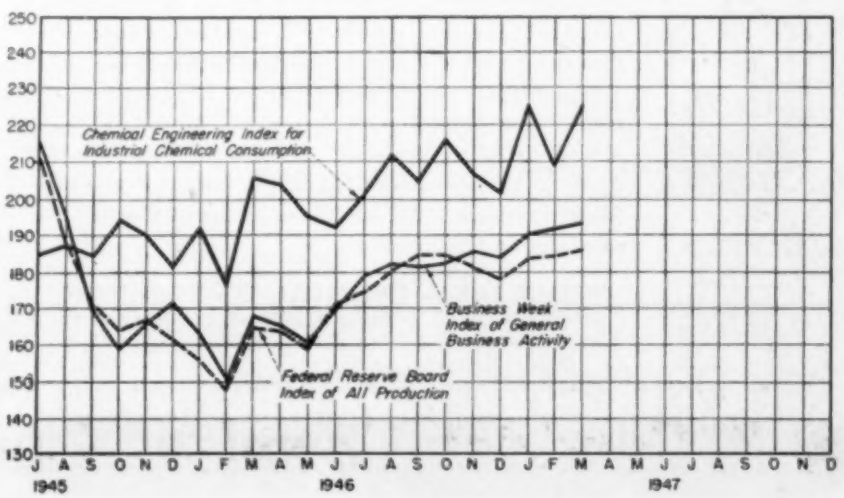
1935 = 100

	Feb. Revised	March
Fertilizers	48.06	49.00
Pulp and paper	21.10	23.50
Petroleum refining	17.60	19.82
Glass	20.70	23.60
Paint and varnish	23.75	24.00
Iron and steel	12.05	13.62
Rayon	19.50	22.55
Textiles	11.36	11.90
Coal products	9.30	10.70
Leather	4.80	4.85
Explosives	6.55	6.50
Rubber	6.50	6.45
Plastics	7.60	8.00
	208.70	224.79

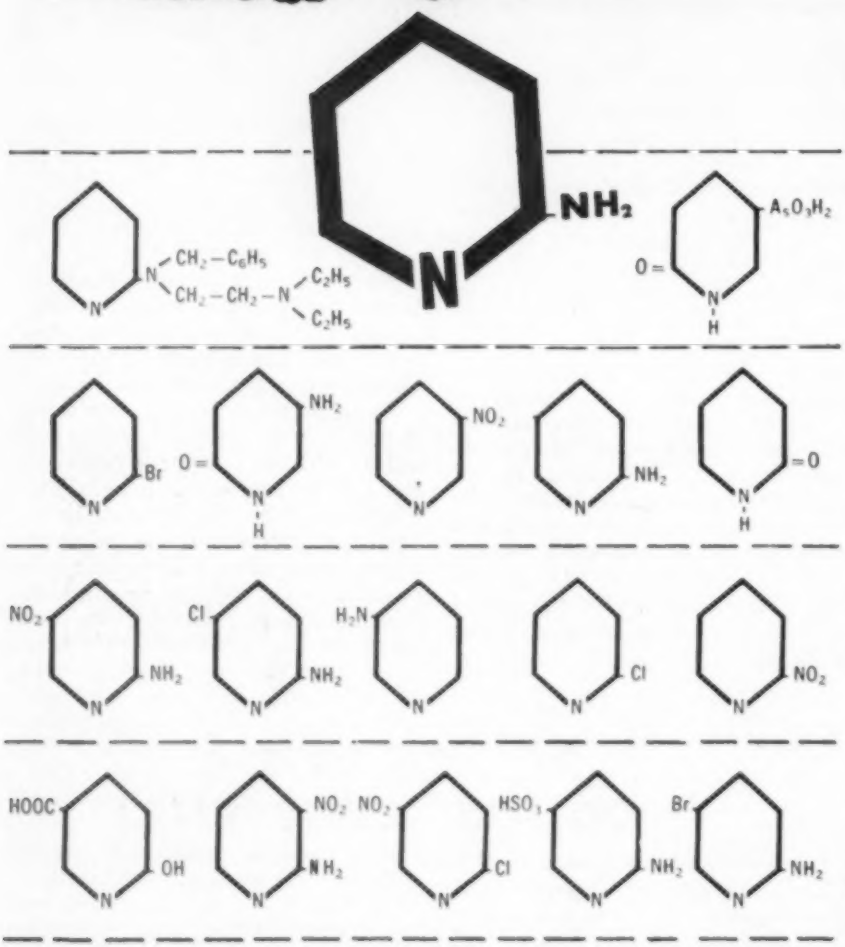
The Department of Commerce early in May reported that production of paper and paperboard in the first two months of this year was 15 percent greater than in the like period a year ago but the average output for the entire year is not expected to maintain the same relative increase. Yet production of paper, pulp and paperboard in March was higher than in either of the two preceding months.

At vegetable oil plants, crushing operations were speeded up in the first quarter with the outturn of crude oils about 15 percent higher than in Jan.-March of 1946. The increase in refined oil production was relatively higher, representing a 20 percent gain over the output of a year ago. In both cases, the larger volumes were due largely to the improved supply position of copra and coconut oil. Soybean oil, which has taken the leadership from cottonseed, continued its expansive trend. There was a drop in production of miscellaneous oils and cottonseed and linseed oils also were turned out in smaller volume than a year ago and will be in small supply until new crop seed reaches the market.

Production of most chemicals is going ahead at a steady pace and while some soft spots have developed in the market, many of the more important chemicals are still scarce and promise to remain so for the remainder of the year.



REILLY 2-AMINOPYRIDINE



FOR THE SYNTHESIS OF PYRIDINE COMPOUNDS

The importance of Reilly 2-Aminopyridine as a basic material for the synthesis of pharmaceuticals, insecticides and fungicides is here indicated by a few of the large number of pyridine compounds that can be readily prepared from this material.

In addition to 2-Aminopyridine, Reilly also furnishes four methyl aminopyridines as follows: 2-Amino-3-Methylpyridine; 2-Amino-4-Methylpyridine; 2-Amino-5-Methylpyridine; and 2-Amino-6-Methylpyridine. All of these aminopyridines are available in 95% purity.

Reilly Coal Tar Chemicals

This 56-page booklet and supplement, describing Reilly Coal Tar Chemicals, Acids, Oils, Intermediates and Bases, will be sent on request.

REILLY TAR & CHEMICAL CORPORATION
Merchants Bank Building • Indianapolis 4, Indiana
500 Fifth Avenue, New York 18, N.Y. • 2513 S. Damen Avenue, Chicago 8, Ill.

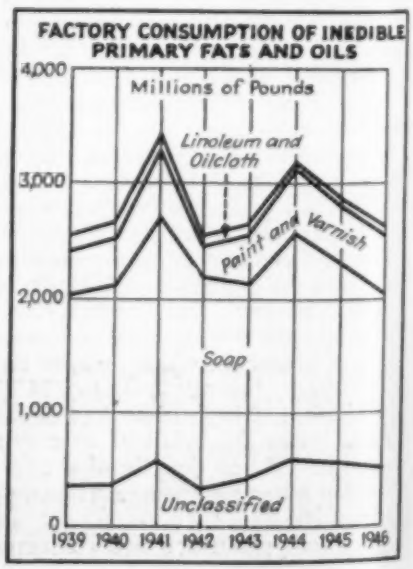
Reilly Coal Tar Chemicals For Industry

Better Outlook for Supply Of Vegetable Oils

With the assurance that large acreages will be planted this season for production of cottonseed, linseed, and soybeans, the outlook is favorable for a more plentiful supply of vegetable oils in the latter part of this year. Furthermore imports of oils should increase and the same holds true for copra and other oil-bearing materials. When price controls were removed, prices for oils began a steady upward climb which carried them to record levels but the market has reversed this trend and while nearby positions have eased only to a moderate degree, a sharp drop has taken place in the case of October-December deliveries. At one time the spread between May and December refined cottonseed oil was approximately 15c. a pound, a differential far above any hitherto experienced in the history of the industry.

The shortage in vegetable oils has been due more to an increase in consuming requirements than to a declining trend in production. Actually domestic outputs of crude oils in the last five years have been considerably higher than in the prewar period. In 1939, production went but little over three billion pounds. In the following years, the output rose consistently with the peak reached in 1943 when a total of 4,158 million pounds were produced. Last year there was a notable drop in the amount of cottonseed and linseed oils turned out and while this was partly offset by larger tonnages of some of the other important oils, the net result was to pull total production down to 3,781 million pounds which still represented a gain of more than 23 percent over the 1939 total.

The outstanding feature in the domestic oil industry is the remarkable growth made by soybean oil in the last



Above—Operation of Offset Herringbone Drift Eliminators in C. H. Wheeler Cooling Towers, described below.

DO YOU SUFFER COOLING TOWER MIST?

Have you ever felt a sudden mist on a clear day, near a water cooling tower? That mist is "drift loss" and to reduce this to an almost imperceptible minimum, Offset Herringbone Eliminators are located near the top of C. H. Wheeler Cooling Towers, as illustrated above. Air passing thru these two layers of blades changes direction and deposits moisture on the underneath side, which builds into drops that fall downward into the tower. This is only one of the many advantages of our 50 Years' Experience in building Induced Draft, Forced Draft and Natural Draft Cooling Towers. Bulletin No. 1044 shows various designs. Write for it today.

C. H. WHEELER MFG. CO.
1808 SEDGLEY AVENUE, PHILA. 32, PA.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

C. H. Wheeler

STEAM CONDENSERS · AIR EJECTORS
COOLING TOWERS · HEAT EXCHANGERS
OF PHILADELPHIA

Chemical and Biological PROCESSING
. . AT 150° BELOW ZERO

Extreme cold without dangerous or costly dry ice or liquefied gases. Bowser mechanical, direct expansion refrigeration provides dependable temperatures to —150° F.

Testing . . . *Research and laboratory testing units also provide instrument controlled heat, vacuum and humidity factors as desired.*

Unit pictured is standard 5 cu. ft. Bowser Chilling Unit for dry or wet processing at sub-zero temperatures.

Production of one of the largest biological processors was materially speeded up and rigid quality control maintained by new Bowser production units installed there.

ENGINEERED BIOLOGICAL & PHARMACEUTICAL UNITS PROVIDE PRODUCTION FACILITIES TO SPECIFICATIONS

Processors of blood, penicillin and plasmas use Bowser units for desiccation and storage Special requirements are readily met by Bowser's engineering and production plant ideally suited for specification work.

Bowser production and testing units are **AVAILABLE NOW**

. . . TO IMPROVE QUALITY
. . . TO INCREASE OUTPUT
. . . TO MAINTAIN UNIFORMITY

BOWSER SERVES CHEMICAL, PHARMACEUTICAL, COSMETIC, BIOLOGICAL, PLASTIC & RUBBER INDUSTRIES

Consider low temperature applications as a possible answer to your production, testing or control problems.

Wherever "dry ice" or "liquid air" is used, Bowser mechanical refrigeration will save money while providing uninterrupted sub-zero temperatures with complete safety and independently of outside sources of expendable material.

----------SPECIFICATION & DATA FOLDERS----------

BOWSER, INC., Terryville, Conn.

Gentlemen: Please rush a full set of specification and data sheets by return mail. We are interested in:

☐ Processing ☐ Testing ☐ _____

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MODELS FOR LABORATORY AND INDUSTRIAL USE

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IN CANADA, S. F. BOWSER, LTD. • 183 GEORGE ST. • TORONTO, ONTARIO

25 years. In 1922, domestic mills turned out about three-quarters of a million pounds. Slow progress was made up to the late 30's but from then on notable gains were registered, culminating in a record output of 1,449 million pounds in 1946. In 1944 soybean oil displaced cottonseed as the ranking oil and has maintained its position up to the present.

End Uses For Chemicals

THE BUREAU of the Census has released further data showing end uses of chemicals based on allocation records of the War Production Board. The data with the periods covered are:

Aqua Ammonia

January 1–June 30, 1943

Use	Tons	Percent
Total allocations	30,927	100.0
Direct military	33	0.1
Other uses	30,894	99.9
Chemical manufacture	11,363	36.7
Soda ash	3,457	11.2
Sulphuric acid	2,720	8.8
Ammonium chloride	2,474	8.0
Copper sulphate	730	2.3
Other chemicals	1,982	6.4
Metal refining	4,153	13.4
Dye intermediates	2,078	6.7
Explosives	1,664	5.4
Yeast manufacturing	1,417	4.6
Textile finishing and rayon manufacturing	828	2.7
Corrosion control	808	2.6
Pharmaceuticals	678	2.2
Fertilizer	623	2.0
Silica gel	615	2.0
Mildew proofing	308	1.0
Small orders	3,216	10.4
Miscellaneous	3,147	10.3

Dipentene

July 1, 1944–December 31, 1944

Use	1,000 gal.	Percent
Total allocations	1,510	100.0
Export	5	0.3
Other uses	1,505	99.7
Rubber processing	1,074	71.1
Lubricants, cleaners, and carbonizing	154	10.2
Protective coating solvents	140	9.9
Disinfectants, insecticides, and soaps	56	3.7
Textiles	28	1.9
Synthetic resins	25	1.7
Miscellaneous	19	1.2

Hexamethylene Tetramine

July 1, 1944–June 30, 1945

Use	1,000 lb.	Percent
Total allocations	12,947	100.0
Export	3,094	23.9
Direct military	1,304	10.1
Resins, plastics, adhesives	7,556	58.4
Miscellaneous	991	7.6

Pine Oil
(Revised Report)

April 1–December 31, 1944

Use	1,000 gal.	Percent
Total allocations	2,785	100.0
Export	340	12.2
Other uses	2,445	87.8
Disinfecting and cleaning	963	34.6
Disinfectants	581	20.9
Industrial cleaning	301	10.8
Laundries	51	1.8
Soaps and cleaning compounds	30	1.1
Textiles	512	18.4
Ore flotation	469	16.8
Paints, varnish, and enamels	128	4.6
Plywood	68	2.4
Paper products	30	1.1
Wood preservatives	26	0.9
Medicinal and pharmaceutical	19	0.7
Rubber	11	0.4
Inks	2	0.1
Miscellaneous	217	7.8

ONE *recognized standard*

THE COTTRELL PROCESS OF ELECTRICAL PRECIPITATION

FOR GAS CLEANING, smoke abatement and removal of dust, fume, tar and other suspended matter from gas, there has been one universally accepted process for more than thirty years. In answer to your special problem, a Cottrell installation incorporating this rich experience in research, development and worldwide operation means the complete fulfillment of your requirements.

RESEARCH CORPORATION

NEW YORK 17: 405 LEXINGTON AVENUE
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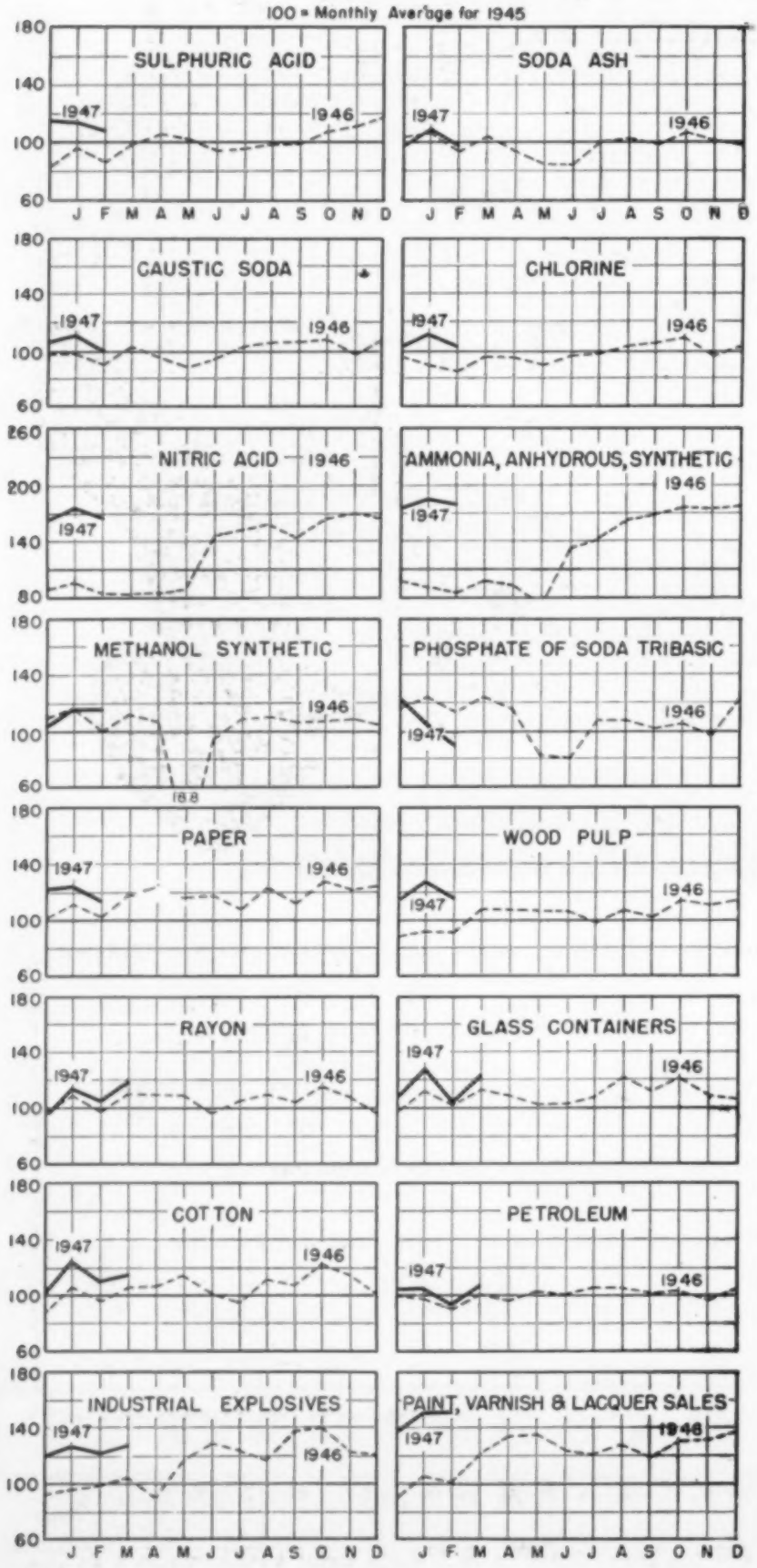
PRODUCTION AND CONSUMPTION TRENDS



WHILE THE declining price trend for some chemical products, notably vegetable oils and fats, tends to cut down the dollar volume of shipments, the physical volume for the industry as a whole continues to hold above the levels of a year ago.

Because of the shortage of salt cake and uncertainty regarding the renewal of imports, it is of interest to note that a reporter for McGraw-Hill World News, writing from Leipzig, says the possibility of the United States receiving up to 20,000 tons of salt cake in the coming year was confirmed at the Leipzig Fair by the Kaiseroda plant, Germany's sole big producer for the world market. The firm, which is located in Thuringia in the Russian zone, must have all orders approved by the Soviet Military Administration in Germany. Consequently inquiries should be made through Russian consulates in the U. S. or by direct contact with SMA in Germany.

The firm disclosed that shipments have been made in the past year to Finland, Sweden and Holland. Presumably the small amounts of German salt cake reported to have been received in the U. S. were re-exports from one of these countries. Holland would be the most likely country to re-export as the Scandinavian countries are in critical need of salt cake for their paper industries.

At the fair, Kaiseroda reported that Berk Inc. of New York already had asked that shipments of 2,000 ton lots be started as soon as possible. Berk formerly was the U. S. distributor for the German firm.

Lack of coal is the present chief bottleneck to production. However, the Soviet authorities have shown such keen interest during the fair in getting dollar balances (for their own use reportedly) that it is likely they will make increased efforts to sustain production with a view to U. S. dollar exports. Kaiseroda, prewar, exported about 50,000 tons annually to the U. S. Sweden formerly took about 60,000 tons and Finland 40,000 tons.

Both the regular grade used principally by the glass, paper and chemical industries and the desiccated or glauber salts grade for the textile and pharmaceutical industries are being produced at Kaiseroda. Kaiseroda also is hoping to resume exports of epsom salts to the United States, and is now producing all varieties. Its production of potassium chloride for fertilizer has been relatively high in view of the shortage of coal.

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

325 WILSON, SO. NORWALK, CONN.

Do you need

—a filter cloth to filter

Acids or Alkalies?

Try

STANLEY'S

"VINYON"

For high temperature filtration we recommend

WOVEN GLASS CLOTH

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Filter Fabrics, Cotton, Wool and Saran in all widths and weaves. By the roll or cut, and fabricated into all shapes and sizes for standard Filter Presses, Drum Filters, and Centrifugals.

Kindly state width and style of cloth required.

WM. W. STANLEY CO., Inc.

401 Broadway, New York 13, N. Y.

United States Production of Certain Chemicals

February 1947, February 1946 and Two-Month Totals for 1947 and 1946

Chemical (Tons unless otherwise noted)	February 1947	February 1946	Total, Two Months 1947	Total, Two Months 1946
Ammonia, synthetic, anhydrous[1]	82,123	39,738	167,244	82,123
Ammonium nitrate (100% NH_4NO_3)	84,070	38,543	173,817	76,238
Ammonium sulphate, synthetic technical (M lb.)	26,791	24,355	51,278	48,851
Calcium arsenate ($Ca_3(AsO_3)_2$) (M lb.)	1,543	1,139	3,308	2,091
Calcium carbide, commercial	45,411	40,316	90 086	85,508
Calcium phosphate:				
Monobasic (100% $CaH_4(PO_4)_2$) (M lb.)	5,794	6,332	12,525	11,911
Dibasic (100% $CaHPO_4$) (M lb.)	6,076	8,083	13,893	16,833
Carbon dioxide:				
Liquid and gas (M lb.)	14,019	15,630	31,650[8]	33,397
Solid (M lb.)	35,539	38,634	78,690	76,957
Chlorine	101,717	84,741	211,805	174,448
Chrome green (C.P.) (M lb.)	1,317	1,803	2,930	3,551
Chrome yellow and orange (C.P.) (M lb.)	3,286	4,147	6,894	8,764
Hydrochloric acid (100% HCl)	33,966	26,791	69,110	53,619
Hydrogen (M cu. ft.)	1,584,000	1,307 000	3,215,000	2,733,000
Lead arsenate, acid and basic (M lb.)	3,691	7,567	8,614	13,988
Molybdate chrome orange (C.P.) (M lb.)	408	397	837	861
Nitric acid (100% HNO_3)	62,193	31,123	126,331	65,892
Oxygen (M cu. ft.)	1,010	606	2,111	1,321
Phosphoric acid (50% H_3PO_4)	74,927	74,425	153,819[8]	147,777
Soda ash:				
Ammonia-soda process:				
Total wet and dry[3]	350,634	342,625	730,223	729,637
Finished light[3]	167,838	168,213	362,663	364,706
Finished dense	129,155	123,048	258,970	255,358
Natural[4]	18,612	16,087	37,294[8]	33,248
Sodium bicarbonate, refined	15,329	13,809	30,814	28,941
Sodium bichromate and chromate	5,954	7,134	12,933	14,889
Sodium hydroxide:				
Electrolytic process:				
Liquid[5]	96,730	81,602	205,418	167,674
Solid	16,695	14,713	34,655	32,470
Lime-soda process:				
Liquid[5]	60,056	61,646	124,817[8]	130,073
Solid	18,395	17,861	39,811	39,479
Sodium phosphate:				
Monobasic (100% NaH_2PO_4)	1,278	1,116	2,373	2,360
Dibasic (100% Na_2HPO_4)	6,034	5,262	12,272	10,988
Tribasic (100% Na_3PO_4)	6,600	8,429	14,411	17,645
Meta (100% $NaPO_3$)	2,168	2,647	4,312	4,919
Tetra (100% $Na_4P_2O_7$)	3,892	5,125	8,003	9,468
Sodium silicate, anhydrous	35,884	32,494	75,875	64,973
Sodium sulphate:				
Anhydrous, refined	10,468	9,320	22,644	19,811
Glauber's salt (100% $Na_2SO_4 \cdot 10H_2O$)[6]	16,433	13,313	33,771	27,139
Salt cake, crude, commercial	46,775	40,505	95,712	78,000
Sulphuric acid:[7]				
Chamber process	279,531	239,515	570,741[8]	495,582
Contact process, new[8]	512,119	384,561	1,059,082[8]	817,239
Zinc yellow (zinc chromate) (C.P.)	283	.....	517	.....

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given data are either confidential or not yet available. [1] Includes a small amount of aqua ammonia. [2] Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finished light and finished dense. [3] Not including quantities converted to finished dense. [4] Data collected in cooperation with the Bureau of Mines. [5] Figures represent total production of liquid material, including quantities evaporated to solid caustic and reported as such. [6] Includes oleum grades, excludes spent acid. [7] Data for sulphuric acid manufactured as a byproduct of smelting operations are included. [8] Revised.

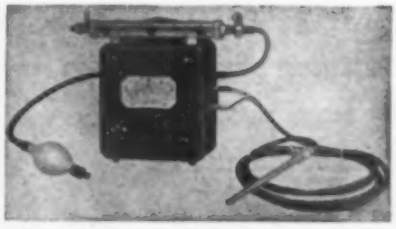
United States Production of Certain Synthetic Organic Chemicals

January 1947, January 1946 and Twelve-Month Total for 1946

Chemical	January 1947	January 1946	Total, Twelve Months 1946
Acetanilid, technical and U.S.P.	727,690	682,255	8,030,566
Acetic acid:			
Synthetic[1]	33,997,431	21,085,179	284,926,531
Recovered	121,412,807	98,123,970	1,191,233,817
Natural[1]	2,154,450	1,807,533	27,303,171
Acetic anhydride[2]	49,157,280	45,733,425	521,979,039
Acetone	31,532,582	25,846,431	335,928,986
Acetylsalicylic acid	925,455	986,368	9,852,167

(Continued on page 334)

The Engelhard Flualizer



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THOMSON PUMPS

U. S. Production of Synthetic Organic Chemicals (Cont. from page 332)

	January 1947	January 1946	Total, Twelve Months 1946
Aniline	8,772,510	7,070,095	89,131,604
Barbituric acid derivatives:[5]			
5-Ethyl-5-phenylbarbituric acid and salts (Phenobarbital)	39,172	29,048	396,059
Benzene:			
Motor grade:			
Tar distillers[3]	686,277	1,064,619	9,034,560
Coke-oven operators[6]	2,172,956	2,636,448	29,734,795
All other grades:			
Tar distillers[4]	1,828,171	1,525,514	19,967,013
Coke-oven operators[6]	12,631,983	6,765,141	107,875,797
Butyl alcohol, primary, normal	13,732,124	9,588,995	125,812,155
Carbon bisulphide	29,187,527	26,764,616	302,543,024
Carbon tetrachloride	15,765,452	11,642,663	145,765,551
Chlorobenzene, mono	25,352,344	22,036,576	268,688,154
Creosote oil:			
Tar distillers	10,896,738	9,852,120	112,235,692
Coke-oven operators	3,341,107	1,915,848	29,773,485
Creosols:			
Meta-para	386,411	228,763	5,493,714
Ortho-meta-para	664,522	551,881	8,165,336
Cresylic acid, refined[7,10]	2,094,021	1,538,772	23,466,453
Dibutyl phthalate	2,044,575		15,341,958
Dichlorodiphenyltrichloroethane (DDT)	4,092,242	3,489,598	44,577,945
Ethyl acetate (85%)	10,964,800	6,430,602	95,765,185
Ethylene glycol	17,554,628		
Ethyl ether, technical and U.S.P.	4,019,229	3,313,097	39,923,379
Formaldehyde (37% by wt.)	46,340,624	39,210,905	460,047,903
Naphthalene:			
Tar distillers	18,713,959	16,035,687	186,413,630
Less than 79° C.			
79° C. and over	8,690,728	8,319,874	95,565,766
Coke-oven operators, less than 79° C.	7,266,151	4,177,253	70,895,672
Methanol:			
Natural	1,467,480	1,402,481	15,315,005
Synthetic	47,408,183	48,054,166	491,635,932
Penicillin	2,872,034	1,513,005	27,108,714
Phenol, natural and synthetic	18,570,782	16,070,489	199,138,233
Phthalic anhydride	9,061,298	9,061,298	109,253,035
Styrene, government owned plants only	33,751,280	27,060,438	374,866,570
Toluene, coke-oven operators	2,010,062	1,295,177	16,966,513
All others	2,077,737	1,131,192	16,989,005

All data in pounds except benzene (gal.) creosote oil (gal.), toluene (gal.), and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1] Excludes the statistics on recovered acid. [2] Acid produced by direct process from wood and from calcium acetate. [3] All acetic anhyride including that from acetic acid by vapor-phase process. [4] Product of distillers who use purchased coal tar only or from oil-gas or water-gas produced or purchased by tar distillers. [5] Statistics are given in terms of bulk medicinals only. [6] Statistics collected by Bureau of Mines. [7] Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8] Reported to U. S. Bureau of the Census. [9] Includes toluene produced from petroleum by any process. [10] Includes refined cresylic acid from petroleum.

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FOR LEAKPROOF, TROUBLE-FREE PIPE RUNS

Cut-a-way view of a Walseal Tee showing ring of silver brazed alloy, and completed Silbraz joint.

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On all types of piping jobs where Type "B" copper or red brass pipe is used, trouble can be avoided by installing Silbraz* joints — made with Walseal valves, fittings and flanges.

Threadless, patented Silbraz joints are silver brazed (not soft soldered) pipe joints that are leakproof, trouble-free — permanent ... connections that will not creep or pull apart; that literally join with the piping system to form a "one-piece pipe line". Thus, these modern joints eliminate the need for maintenance and costly repairs — especially important where lowered operating costs are imperative.

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Like an atomic blast, flames leap above the doomed plant. Lightning had started it—nothing to stop it. C-O-Two immediately locates fire, signals an alarm and snuffs out the fire.

On the night of July 3, 1946, lightning struck the rear section of a building of a large textile mill. Before the fire department arrived, the whole structure was in flames. Despite later assistance of three fire departments from neighboring towns, flames spread and destroyed two plants and several warehouses. The next morning showed a total loss of $3,800,000. Cause: inoperative and inadequate protection.

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CHEMICAL ENGINEERING

Weighted Index of Prices for CHEMICALS

Base = 100 for 1937

This month	123.54
Last month	125.94
May, 1946	109.13
May, 1945	108.97

CURRENT PRICES

The accompanying prices refer to round lots. Where it is trade custom to sell f.o.b. works, quotations are so designated. Prices are corrected to May 12.

INDUSTRIAL CHEMICALS

Acetone, tank, lb	$0.07 - $0.00
Acid, acetic, 28%, bbl., 100 lb	3.78 - 4.03
Boric, bbl., ton	119.00 -123.00
Citric, drums, lb	.24½- .26
Formic, cbys., lb	.12 - .12½
Hydrofluoric, 30%, drums, lb	.08 - .085
Lactic, 44% tech., light, bbl., lb	.073- .075
Muriatic, 18°, tanks, 100 lb	1.05 -
Nitric, 36°, carboys, lb	.05 - .05
Oleum, tanks, wks., ton	19.50 - 20.00
Oxalic, crystals, bbl., lb	.13 - .14
Phosphoric tech., tanks, lb	.0465-
Sulphuric, 60°, tanks, ton	13.00 -
Tartaric, powd., bbl., lb	.49½- .50
Alcohol, amyl from pentane, tanks, lb	.15½-
Alcohol, butyl, tanks, lb	.14½- .29
Alcohol, ethyl, denatured, No. 1 special, tanks, gal	.98½-
Alum, ammonia, lump, lb	.04½-
Aluminum sulphate, com. bags, 100 lb	1.15 - 1.25
Ammonia, anhydrous, cyl., lb	.18 - .20
tanks, ton	59.00 - 61.50
Ammonium carbonate, powd., casks, lb	.09½- .10
Sulphate, wks., ton	30.00 - 32.00
Amyl acetate, tech. from pentane, tanks, lb	.21 -
Aqua ammonia, 26°, drums, lb	.03 - .03½
tanks, ton	55.00 -
Arsenic, white powd., bbl., lb	.06 - .07
Barium carbonate, bbl., ton	67.50 - 75.00
Chloride, bags, ton	80.00 - 90.00
Nitrate, casks, lb	.09½- .11
Blanc fixe, dry, bags, ton	67.50 - 72.50
Bleaching powder, f.o.b. wks., drums, 100 lb	2.75 - 3.00
Borax, gran., bags, ton	48.50 -
Calcium acetate, bags, 100 lb	3.00 -
Arsenate, dr., lb	.09 - .10
Carbide, drums, ton	50.00 -
Chloride, flake, bags, del., ton	21.50 - 38.00
Carbon bisulphide, drums, lb	.05 - .05½
Tetrachloride, drums, lb	.06½- .07
Chlorine, liquid, tanks, wks., 100 lb	2.00 - 2.30
Copperas, bgs., f.o.b., wks., ton	17.00 - 18.00
Copper carbonate bbl., lb	.26 - .27
Sulphate, bags, 100 lb	7.60 - 7.75
Cream of tartar, bbl., lb	.41½- .42
Diethylene glycol, dr., lb	.14 - .15
Epsom salt, dom., tech., bbl., 100 lb	2.05 - 2.25
Ethyl acetate, tanks, lb	.09½- .21½
Formaldehyde, 30%, tanks, wks., lb	.037-
Furfurs ,tanks, lb	.09½-
Glauber's salt, bags, 100 lb	1.25 - 1.50
Glycerine, c. p., drums, extra, lb	.60 .55
Lead:	
White, basic carbonate, dry casks, lb	.15½-
Red, dry, sck., lb	.13 -
Lead acetate, white crys., bbl., lb	.19½- .20½
Arsenate, powd., bags, lb	.21½- .22
Lithopone, bags, lb	.05½- .06
Magnesium carb., tech., bags, lb	.07½- .08
Methanol, 95%, tanks, gal	.60 -
Synthetic, tanks, gal	.24 - .29
Phosphorus, yellow, cases, lb	.22 - .25
Potassium bichromate, bags, lb	.10½- .10½
Chlorate, powd., lb	.11 - .11½
Hydroxide (c'stic potash) dr., lb	.07½- .09½
Muriate, 60%, bags, unit	.53½-
Nitrate, ref., bbl., lb	.08½- .21
Permanganate, drums, lb	.20½- .21½
Prussiate, yellow, casks, lb	.19 - .20
Sal ammoniac, white, casks, 100 lb	4.75 - 5.00
Salsoda, bbl., 100 lb	1.10 - 1.20
Salt cake, bulk, ton	20.00 -
Soda ash, light, 58% contract, bags, 100 lb	1.20 -
Dense, bags, 100 lb	1.28 -
Soda, caustic, 76% solid, drums, 100 lb	2.50 -
Acetate, del., lb	.05½- .06
Bicarbonate, bags, 100 lb	2.25 -
Bichromate, bags, lb	.08½- .08½
Bisulphate, bulk, ton	20.00 - 24.00
Bisulphite, bbl., lb	.03 - .04

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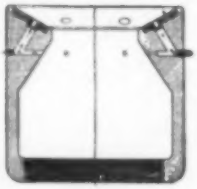

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CHEMICAL ENGINEERING

Weighted Index of Prices for OILS & FATS

Base = 100 for 1937

This month	**272.16**
Last month	345.62
May, 1946	145.80
May, 1945	145.85

Chlorate, kegs, lb	$0.06½ –	$0.06¾
Cyanide, cases, dom., lb	.14½ –	.15
Fluoride, bbl., lb	.09½ –	.09¾
Hyposulphite, bags, 100 lb	2.25	2.50
Metasilicate bbl., 100 lb	3.40 –	4.00
Nitrate, bulk ton	32.00 –	38.50
Nitrite, casks, lb	.06½ –	.07
Phosphate, tribasic, bags, 100 lb	3.50 –	
Prussiate, yel., bags, lb	.12 –	.12½
Silicate, 40°, dr., wks., 100 lb	.95 –	1.00
Sulphite, crys., bbl., lb	.02½ –	.02¾
Sulphur, crude at mine, long ton	16.00 –	
Dioxide, cyl., lb	.085–	.09
Dioxide, tanks, lb	.044–	
Tin crystals, bbl., lb	.55 –	
Zinc chloride, gran., bbl., lb	.07 –	.07½
Oxide, lead free, bags, lb	.09½ –	.09¾
Oxide, 35% leaded, bags, lb	.11½ –	.11¾
Sulphate, bags, cwt	4.15 –	7.00

OILS AND FATS

Castor oil, No. 3 dr., lb	$0.32½–	
Chinawood, oil, tanks, lb	.32 –	
Coconut oil, Ceylon, N. Y., lb	.17½–	
Corn oil, crude, tanks, (f.o.b. mill), lb	.23 –	
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.25 –	
Linseed oil, raw, car lots, dr., lb	.385–	
Palm, casks, lb	nom.	
Peanut oil, crude, tanks (mill), lb	.25 –	
Rapeseed oil, refined, bbl., lb	.32	
Soybean, tanks, lb	.23 –	
Menhaden, light, pressed dr., lb	.27½–	
Crude, tanks (f.o.b. factory), lb	nom.	
Grease, yellow, loose, lb	.14½–	
Oleo stearine, lb	nom.	
Oleo oil, No. 1, lb	.23 –	
Red oil, distilled, bbl., lb	.22 –	
Tallow, extra, loose, lb	.14½–	

COAL TAR PRODUCTS

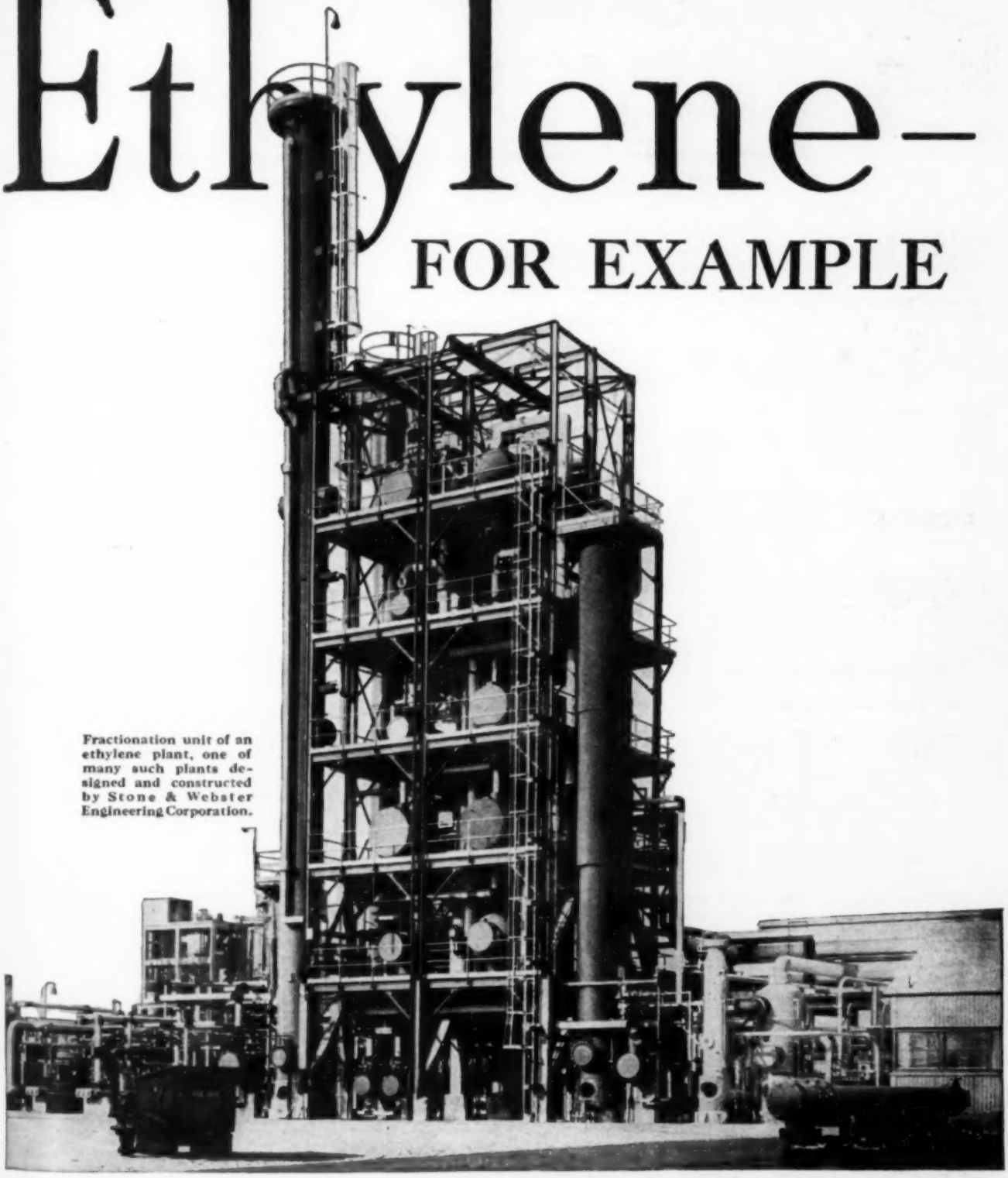
Alpha-naphthol, crude, bbl., lb	$0.58 –	$0.60
Alpha-naphthylamine, bbl., lb	.35 –	.36
Aniline oil, drums, lb	.13 –	.13½
Aniline salts, bbl., lb	.22 –	.24
Benzaldehyde, tech., dr., lb	.45 –	.50
Benzidine base, bbl., lb	.75 –	.77
Benzoic acid, USP, kegs, lb	.54 –	.56
Benzol, 90%, tanks, works, gal	.19 –	
Benzyl chloride, tech., dr., lb	.20 –	.21
Beta-naphthol, tech., drums, lb	.23 –	.24
Cresol, USP, dr., lb	.13½–	
Cresylic acid, dr., wks., gal	1.00 –	1.05
Diphenyl, bbl., lb	.16 –	
Diethylaniline, dr., lb	.48 –	.50
Dinitrotoluol, bbl., lb	.18 –	.19
Dinitrophenyl, bbl., lb	.22 –	.23
Dip oil, 15%, dr., gal	.23 –	.25
Diphenylamine, dr., f.o.b. wks., lb	.25 –	
H acid, bbl., lb	.50 –	.52
Hydroquinone, bbl., lb	.90 –	.95
Naphthalene, flake, bbl., lb	.09½–	.10
Nitrobenzene, dr., lb	.08½–	.09
Para-cresol, bbl., lb	.41 –	
Para-nitroaniline, bbl., lb	.42 –	.43
Phenol, USP, tanks, lb	.10½–	.11
Picric acid, bbl., lb	.30 –	.32
Pyridine, dr., gal	1.55 –	1.60
Resorcinol, tech., kegs, lb	.68 –	.70
Salicylic acid, tech., bbl. lb	.26 –	.27
Solvent naphtha, w.w., tanks gal.	.23 –	
Toluidin, bbl., lb	1.00 –	
Toluol, drums, works, gal	.23 –	
Xylol, com., tanks, gal	.23 –	

MISCELLANEOUS

Casein, tech., bbl., lb	$.25–.30–	$.35
Dry colors:		
Carbon gas, black (wks.), lb	.04 –	.07
Prussian blue, bbl., lb	.42 –	.43
Ultramarine blue, bbl., lb	.13 –	.24
Chrome green, bbl., lb	.31 –	.40
Carmine red, tins, lb	5.50 –	6.00
Para toner, lb	.80 –	.95
Vermilion, English, bbl., lb	2.50 –	2.70
Chrome yellow, C. P., bbl., lb	.26 –	.28
Gum copal, Congo, bags, lb	.09 –	.55
Manila, bags, lb	.09 –	.15
Damar, Batavia, cases, lb	.10 –	.22
Kauri, cases, lb	.18 –	.60
Magnesite, calc., ton	58.75 –	
Pumice stone, lump, bbl., lb	.05 –	.07
Rosin, H., 100 lb	8.55 –	
Shellac, orange, fine, bags, lb	.64 –	.65
Bleached, bonedry, bags, lb	.65 –	.68
T. N. bags, lb	.62 –	.64
Turpentine, gal	.60 –	

Ethylene—

FOR EXAMPLE



Fractionation unit of an ethylene plant, one of many such plants designed and constructed by Stone & Webster Engineering Corporation.

Over a half century of broad experience qualifies our organization to assume full responsibility for all phases of design, engineering and construction of projects in the petroleum and chemical industries.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

NEW CONSTRUCTION

	Current Projects		Cumulative 1947	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$7,900,000	.....	$8,895,000	$2,162,000
Middle Atlantic	575,000	706,000	5,412,000	10,355,000
South	.....	747,000	8,656,000	7,404,000
Middle West	11,100,000	1,513,000	14,483,000	6,445,000
West of Mississippi	121,245,000	16,360,000	178,098,000	56,376,000
Far West	.....	5,899,000	2,840,000	9,761,000
Canada	.....	.....	34,956,000	9,886,000
Total	$140,820,000	$25,225,000	$253,340,000	$102,389,000

Proposed Work

Ark., Little Rock—Texas Eastern Transmission Co., Esperson Bldg., Houston, Tex., plans to construct an 18,000 hp. compressor station. Brown & Root, Inc., 4300 Calhoun Rd., Houston, Cons. Engrs. Estimated cost $1,300,000.

Mass., Cambridge—Polaroid Co., 209 Massachusetts Ave., plans to construct additions to its plant. Estimated cost $900,000.

Mass., Everett—Monsanto Chemical Co., Chemical Lane, plans to enlarge its factory. J. R. Worcester & Co., 79 Milk St., Boston, Cons. Engrs. Estimated cost $7,000,000.

N. M., Eunice—Skelly Oil Co., Skelly Bldg., Tulsa, Okla., plans to double the capacity of its natural gasoline plant here. Estimated cost $1,000,000.

O., Dayton—Texas Eastern Transmission Corp., Esperson Bldg., Houston, Tex., plans to construct a compressor station here. Brown & Root, Inc., 4300 Calhoun Rd., Houston, Cons. Engrs. Estimated cost $1,000,000.

O., Garrettsville—Polson Rubber Co., Garrettsville, plans to construct a 1 story, 50 x 60 ft. rubber mill room. James F. Mumper Co., Everett Bldg., Akron, Eng. Estimated cost $100,000.

O., Lima—Standard Oil Co. of Ohio, Midland Bldg., Cleveland, plans to construct a catalytic cracking unit, gas plant, water cooling tower, gasoline treating and blending facilities and tankage addition. Estimated cost $10,000,000.

Pa., Philadelphia—Atlantic Refining Co., 260 South Broad St., plans to construct a package warehouse extension and two refinery additions. Estimated cost $265,000, $229,810 and $81,000 respectively.

Tex., Freeport—Dow Chemical Co., Freeport, plans to enlarge its chemical plant. Estimated cost $100,000,000.

Tex., Houston—Texas Eastern Transmission Co., Esperson Bldg., Houston, plans to construct a compressor station. Estimated cost $1,300,000.

Tex., Orange—Kemso Chemical Co., Inc., M & M Bldg., Houston, plans to construct a chemical plant and warehouse. Estimated cost $90,000 and $55,000 respectively.

Tex., Texas City—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., plans to rebuild its chemical plant here recently destroyed by fire. Estimated cost $15,000,000.

Tex., Winnie—McCarthy Chemical Co., c/o Glenn H. McCarthy, Sterling Bldg., Houston, is having plans prepared by Wyatt C. Hedrick, Archt. & Cons. Eng., 5201 Fannin St., Houston, for the second unit of its chemical plant. Estimated cost $2,500,000.

Contracts Awarded

Ala., Muscle Shoals—Tennessee Valley Authority, New Sprankle Bldg., Knoxville, Tenn., will construct a chemical laboratory here. Work will be done with own forces. Estimated cost $622,000.

Calif., Berkeley—Wesco Waterpaints, Inc., 5th and Grayson Sts., has awarded the contract for plant buildings to John F. Tulloch, 3428 Ettie St., Oakland, at $71,691.

Calif., Los Angeles—Minnesota Mining & Manufacturing Co., 631 South Anderson St., has awarded the contract for a 1 story, 100 x 200 ft. rubber cement plant and a 1 story, 50 x 100 ft. mixing room to Wililam P. Neil Co., Ltd., 4814 Loma Vista Ave., at $345,000.

Calif., Richmond—Standard Oil Co. of California, 225 Bush St., San Francisco, has awarded the contract for a grease works plant and packaging warehouse to Barett & Hilp, 918 Harrison St., San Francisco. Estimated cost $5,000,000.

Calif., Vernon—National Lead Co., 922 Wilson St., Los Angeles, has awarded the contract for a 3 story paint factory, 1 story office and 1 story warehouse, to Fred E. Potts Co., 2516 12th Ave., Los Angeles. Estimated cost $482,000.

Colo., Rangel—Standard Oil Co. of California, 225 Bush St., San Francisco, has awarded the contract for a casinghead gasoline plant and compressor plant to Hudson Engineering Corp., Houston, Tex. Estimated cost $4,006,000.

Ill., Chicago—Dryden Rubber Co., 1014 South Kildare St., has awarded the contract for a 2 story, 60 x 118 ft. addition to its factory to John Griffith & Son, 228 North La Salle St., Chicago. Estimated cost $153,000.

Ill., Chicago—West Disinfecting Co., 2635 Cottage Grove Ave., has awarded the contract for a 2 story factory to Poirot Construction Co., 2001 West Pershing Rd. Estimated cost $160,000.

Ia., Des Moines—Lake Shore Tire & Rubber Co., 24th St., has awarded the contract for a warehouse to Arthur H. Neumann & Bros., Inc., Hubbell Bldg. Estimated cost $250,000.

Mo., St. Louis—Mallinckrodt Chemical Works, 3600 North Second St., has awarded the contract for two 1 story factory buildings to Dickie Construction Co., 317 North 11th St.

Mo., St. Louis—Monsanto Chemical Co., 1700 South Second St., has awarded the contract for a 1 story, 40 x 100 ft. steel storage building to I. E. Millstone Construction Co., 4343 Clayton Ave.

N. J., Parlin—E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has awarded the contract for a 2 story addition to its plant here to Wigton-Abbott Corp., 1225 South Ave., Plainfield. Estimated cost $65,000.

O., Youngstown—General Fireproofing Co., East Dennick Ave., has awarded the contract for a 4 story plant addition to Joseph Bucheit & Sons Co., 819 Mahoning Ave. Estimated cost $1,000,000.

Pa., Creighton—Pittsburgh Plate Glass Co., Pittsburgh, has awarded the contract for a 3 story plant addition to Mellon-Stuart Co., 210 East Parkway, N. S., Pittsburgh. Estimated cost $350,000.

Pa., Washington—Tygart Valley Glass Co., Washington, will construct addition to its plant. Work will be done by separate contracts: steel to Pittsburgh Bridge & Iron Works, Union Bank Bldg., Pittsburgh. Estimated cost $290,729.

Tex., Brownsville—Carthage Hydrocol, Inc., subsidiary of Hydrocarbon Research, Inc., 115 Broadway, New York, N. Y., has awarded the contract for a carthage hydrocol gasoline and chemical plant to Arthur G. McKee & Co., 2300 Chester Ave., Cleveland, O. Estimated cost $5,000,000.

Tex., Pasadena—Sinclair Refining Co., Gulf Bldg., Houston, has awarded the contract for a 4 story, 100 x 300 ft. barrel house, additional expansion of its refinery plant units, crude oil pipe still, etc., to Fluor Corp., Ltd., 2500 Atlantic Bldg., Los Angeles. Estimated cost $7,000,000.

W. Va., Charleston—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., has awarded the contract for an addition to service building at nitro plant, to J. V. Pettyjohn Co., Lynchburg, Va. Estimated cost $125,000.

Wis., Fond du Lac—Fred Rueping Leather Co., 96 Doty St., has awarded the contract for a 2 story, 60 x 100 ft. addition to its refinery to Immel Co., 562 North Main St. Estimated cost $200,000.